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TICAL EVALUATION OF THE EFFECTIVENESS OF FEDERAL MOTOR HICLE SAFETY STANDARD 207: SEAT BACK LOCKS (ONLY)

Report No. 3 of 7

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OCTOBER 1980
FINAL REPORT

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16. Abstract

This is the final report on the statistical evaluation of Federal Motor Vehicle Safety Standard (FMVSS) 207: Seat Back Locks (Only). It is one of seven statistical evaluations conducted under this contract. The seven Standards are:

1. FMVSS 10B: Side Marker Lamps (Only)
2. FMVSS 202: Head Restraints
3. FMVSS 207: Seat Back Locks (Only)
4. FMVSS 213: Child Restraints
5. FMVSS 214: Side Door Beams
6. FMVSS 222: School Bus Seating and Crash Protection
7. FMVSS 301: Fuel System Integrity

FMVSS 207 is a death-and-injury-reduction Standard which requires a self-locking restraining device for folding seats and seat backs, that must meet specified static load tests. The Standard became effective 1 January 1968.

More than 600,000 cases of driver involvement in frontal collisions were analyzed using mass accident data from Texas (1972-1974), New York (1974) and North Carolina (1973-1975). Contingency table data were subjected to log-linear modeling and adjustment to minimize potential confounding effects and allow direct comparison of injury rates between drivers of 2-door and 4-door cars. The results of the analyses do not support the hypothesis that the introduction of seat back locks in 2-door passenger cars reduces the injury risk to drivers in these cars.

While the analysis was not completely successful in removing all confounding effects, it can be inferred that the effect of seat back locks on driver injury risk, if any, is amall and very difficult to quantify, given the potential for confouncing effects from the implementation of other Standards and the possible interactive effects between vehicle body style and weight and driver characteristics.

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was very clearly settled by the analysis of FARS data. The results successfully demonstrated that any negative effect due to entrapment is far outweighed by the beneficial effect of a rigid seat back confining rear seat passengers to the rear area during a collision.

A brief, limited study of computerized NCSS data from April 1978 through 1979 was conducted to study data on driver injury and seat failure. The data indicated that the likelihood of fatal or critical injury is about five times greater given seat failure. Conversely, the probability of escaping any injury is about three times higher with no seat failure, compared to cases of seat failure. However, the NCSS-derived seat failure rates for Post-Standard cars were not lower than those for Pre-Standard cars.

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METRIC CONVERSION FACTORS

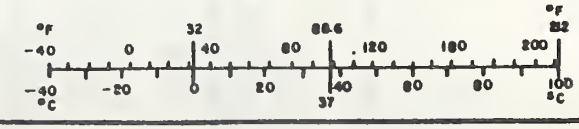
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	litres	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



CONTRACT TECHNICAL MANAGER'S ADDENDUM

Prepared for the National Highway Traffic Safety Administration in support of a program to review existing regulations, as required by Executive Order 12044 and Department of Transportation Order 2100.5. Agency staff will perform and publish an official evaluation of Federal Motor Vehicle Safety Standard 207 based on the findings of this report as well as other information sources. The values of effectiveness and benefits found in this report may be different from those that will appear in the official Agency evaluation.

EXECUTIVE SUMMARY

This is the Final Report of the statistical evaluation of the effectiveness of Federal Motor Vehicle Safety Standard (FMVSS) 207: Seat Back Locks (Only).

FMVSS 207 is a death-and-injury reduction Standard which requires a self-locking restraining device for folding seats and seat backs, that must meet specified static load tests. The Standard became effective 1 January 1968.

The principal objective of this analysis is to determine if the effects of seat back locks on injury avoidance can be determined from statistical analyses of existing mass accident data from Texas (1972-1974), New York (1974) and North Carolina (1973-1975). A total of over 600,000 cases of driver involvement in frontal collisions are analyzed. Only domestic vehicles of known body style, make-model and model year that were involved in single vehicle or two-vehicle accidents were included.

Other objectives are (1) to analyze the fatality rate of front and rear seat occupants using Fatal Accident Reporting System (FARS) data, to determine whether seat back locks increase the possibility of rear seat occupants being trapped and killed in panic situations where quick emergency exit from the car is required and (2) to analyze a limited computerized portion of National Crash Severity Study (NCSS) data on seat failure and injury.

The purpose of these evaluations is to provide a better understanding of the effects of seat back locks on deaths and injury severity. The basic measure of effectiveness is defined as follows:

$$\left[\begin{array}{c}\text{Effectiveness}\\ \text{of Seat Back}\\ \text{Locks}\end{array}\right] = \left[1 - \left\{\frac{\text{Injury Rate for Drivers of Post-Standard, 2-Door Cars}}{\text{Injury Rate for Drivers of Pre-Standard, 2-Door Cars}} \times \frac{\text{Injury Rate for Drivers of Pre-Standard, 4-Door Cars}}{\text{Injury Rate for Drivers of Post-Standard, 4-Door Cars}}\right\}\right] \times 100$$

Thus, effectiveness is measured by computing the percent difference between the Pre- to Post-Standard ratio of injury rates for drivers of 2-door and 4-door cars, respectively. This effectiveness measure is formulated with the realization that 4-door cars received the same modifications (which were mandated by other Standards that went into effect at about the same time as FMVSS 207) as were made in 2-door cars, except the seat back lock. Thus, by looking at the changes in injury distributions of drivers of 2-door cars before and after the implementation

of the Standard and comparing this with the analogous data for drivers of 4-door models, one can expect to assess the impact of the Standard on injury reduction. In effect, the 4-door vehicles are being treated as a control group.

Before effectiveness values were computed, the data were smoothed by fitting hierarchical, log-linear models to contingency tables composed of the variables Injury, PrePost, Vehicle Body Style (2-door or 4-door) and selected control variables for each state-year of data. Three distinct injury dichotomies were used: KA vs. BCO, KAB vs. CO and KABC vs. O. Modeling served the dual purpose of smoothing the data by removing random variability due to small cell frequencies, and of revealing the strength and pattern of various interactions among the variables comprising the contingency tables.

The smoothed data were then adjusted (standardized) to allow for the direct comparison of injury rates. Adjustment of the data was necessary in order to insure that the overall effectiveness estimates were not affected by different distributions of Pre- and Post-Standard, 2-door and 4-door vehicles across different levels of control variables. On the average, the net impact of modeling and adjustment was to increase the value of effectiveness estimates by roughly two to three percent, while slightly reducing the variability of these estimates.

The results of the analyses--shown in the table below--do not support the hypothesis that the introduction of seat back locks in 2-door passenger cars reduces the injury risk to drivers in these cars. That is, the results do demonstrate that this aspect of the Standard has not been significantly effective in reducing injury on a broad basis.

OBSERVED EFFECTIVENESS* OF SEAT BACK LOCKS
IN STATE ACCIDENT DATA, FRONTAL CRASHES

State	Year	KABC vs O		KAB vs CO		KA vs BCO	
		Effectiveness	Standard Deviation	Effectiveness	Standard Deviation	Effectiveness	Standard Deviation
Texas	1972	-1.6 %	2.9 %	-1.3 %	3.5 %	4.9 %	6.1 %
	1973	-0.7	2.9	-3.5	3.6	-12.7	7.6
	1974	-8.3	3.4	-10.3	4.3	1.9	7.7
New York	1974	-7.2	3.1	-12.1	4.4	-17.9	8.9
North Carolina	1973	-7.9	6.8	-3.7	8.8	-44.4	23.5
	1974	-14.6	7.4	-19.9	10.6	-19.0	20.9
	1975	5.6	6.0	14.9	7.5	26.5	13.7

*See effectiveness formula on page v.

While the analysis was not completely successful in removing all confounding effects, it is reasonable to infer that the effect of seat back locks on driver injury risk, if any, is small and very difficult to quantify, given the potential for confounding effects from the implementation of other Standards, the steady increase in sales of 2-door cars (and the corresponding decrease in 4-door car sales) since 1966, vehicle weight differences among 2-door and 4-door cars, and potential differences of age, sex, socioeconomic and personality factors between drivers of 2-door and 4-door cars.

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was also examined by testing the hypothesis that the presence of seat back locks increases the probability of rear seat occupants of 2-door, Post-Standard cars being killed as a result of their being trapped by the seat back lock in panic situations. Empirically, this "trapping" effect was defined as:

$$\left[\begin{array}{c}\text{Trapping}\\ \text{Effect}\end{array}\right] = \left[\left\{\frac{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Post-Standard, 2-Door Cars}\end{array}}{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Pre-Standard, 2-Door Cars}\end{array}} \times \left\{\frac{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Pre-Standard, 4-Door Cars}\end{array}}{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Post-Standard, 4-Door Cars}\end{array}}\right\} - 1\right] \times 100$$

Results obtained from 1975-1978 FARS data indicate that there is an estimated 19 percent decrease in the Pre- to Post-Standard ratio of *rear seat* occupant fatality rates corresponding to 2-door, Post-Standard vehicles. It can be speculated that any potential adverse effect due to entrapment is outweighed by the beneficial effect of a rigid seat back which acts as a restraint on the forward movement of rear seat passengers in a crash, thus reducing the likelihood of serious or fatal injury. In any event, the data do not support the hypothesis that seat back locks increase fatalities due to their trapping effect.

A brief, limited study of computerized NCSS data from April 1978 through 1979 was conducted to study data on driver injury and seat failure. Here, seat failure refers to seat deformation as well as failure of the seat adjuster, seat track or seat back locks. The data indicated that the likelihood of fatal or critical injury is about five times greater given seat failure; the probability of escaping any injury is about three times higher with no seat failure, compared to cases with seat failure.NCSS-derived seat failure rates for Post-Standard cars, however, were not lower than those for Pre-Standard cars.

ACKNOWLEDGMENTS

The work performed by CEM in statistically evaluating the effectiveness of seven Federal Motor Vehicle Safety Standards is the product of an interdisciplinary team effort.

Dr. Gaylord Northrop is the Principal Investigator of this project, and participated in the development and implementation of the approach and the analyses of the results. Mr. John Ball and Mr. Jim Knoop are the principal authors of this report. Mr. Edward Sweeton contributed to the computer processing and analysis.

Other members of the Study Team who contributed in various ways to the report include:

Ms. Kayla Costenoble
Mr. Thomas Bzik
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Mr. Joseph Reidy
Dr. Michael Sutherland
Dr. Brian Hickie

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This study has benefitted throughout from the detailed reviews and constructive comments of the NHTSA Contract Technical Manager, Dr. Charles Kahane. Any errors in analysis or interpretation of data and results are, of course, solely the responsibility of the authors of this report.

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ABBREVIATIONS USED

FMVSS	Federal Motor Vehicle Safety Standard
CEM	The Center for the Environment and Man, Inc.
HSRC	Highway Safety Research Center
FARS	Fatal Accident Reporting System
NHTSA	National Highway Traffic Safety Administration
TAD	Traffic Accident Data Vehicle Damage Scale
KABCO	"K" Killed; "A", "B", "C" Injury Levels; "O" No Injury
BMDP	Biomedical Computer Programs
NCSS	National Crash Severity Study
AIS	Abbreviated Injury Scale
SAE	Society of Automotive Engineers

1.0 INTRODUCTION

1.1 Background

This report is the third in a series of Task 3 Final Reports on the statistical evaluation of the effectiveness of seven Federal Motor Vehicle Safety Standards (FMVSS). This work has been conducted under Contract DOT-HS-8-02014 by The Center for the Environment and Man, Inc. (CEM) and its subcontractor, The Highway Safety Research Center (HSRC) of the University of North Carolina. The seven FMVSS statistically evaluated are:

- FMVSS 108: Side Marker Lamps (Only)
- FMVSS 202: Head Restraints
- FMVSS 207: Seat Back Locks (Only)
- FMVSS 213: Child Seating Systems
- FMVSS 214: Side Door Beams
- FMVSS 222: School Bus Seating and Crash Prevention
- FMVSS 301: Fuel System Integrity

The statistical evaluation of the effectiveness of FMVSS 207 (Seat Back Locks only) is presented in this report. Previous work is described in [1] and [2].

FMVSS 207 originally went into effect on 1 January 1968, at which time it was applicable to passenger cars only. The Standard was basically adapted from the Society of Automotive Engineers (SAE) Recommended Practice J879 which originally appeared in November 1963. The major impact of the Standard was that it required a self-locking restraint device for folding seats and seat backs. In fact, the introduction of seat back locks was the only apparent change made by the manufacturers in response to FMVSS 207. The application of the Standard was extended to multipurpose passenger vehicles, trucks and buses as of 1 January 1972. At this time, additional requirements and specifications were added to the Standard, including the proviso that the seat remain in its adjusted track position during load application. In addition, various aspects of the Standard were clarified and restructured.

The general requirements of FMVSS 207 are listed below. They apply to passenger cars, multipurpose passenger vehicles, trucks and buses.

1. Each occupant seat, with the exception of folding auxiliary jump seats and side facing seats, must be able to withstand specified loads in forward and rearward longitudinal directions. These loads include an amount equal to 20 times the weight of the seat and a load equal to a 3300 inch pound moment about a defined seating reference point. The seat must remain in its adjusted position during the application of each force.
2. With the exception of a passenger seat in a bus or a seat having a back that is adjustable only for the comfort of its occupants, hinged or folding seats or seat backs must

be equipped with a self-locking restraining device. Each device must have a release control. The device must not release or fail when:

- A force of 20 times the weight of the seat back is applied through the center of gravity of a forward facing seat back, or
- A force of 8 times the weight of the seat back is applied through the center of gravity of a rearward facing seat back.

Additionally, the restraining device must not release or fail when subjected to an acceleration of 20 g.

3. The control for releasing the restraining device must be readily accessible to the seat occupant. It must also be readily accessible to any occupant in a seat immediately to the rear.

4. Seats that are not designated for occupancy while the motor vehicle is in motion must be conspicuously labeled to that effect.

There are two important factors related to the evaluation of the effectiveness of FMVSS 207 which should be noted:

1. Between the model years MY 66 and MY 72 there was a significant shift in sales from 4-door to 2-door cars (see Table 3-1, page 3-2). This trend must be taken into account in the evaluation of FMVSS 207. Possible implications of this market shift are discussed when appropriate in Section 3.1.

2. FMVSS 207 and many other Standards were applied nearly simultaneously during the late 1960's. It is not immediately obvious as to how to distinguish between the effects of one Standard and another; for example, FMVSS 207 (Seat Back Locks, Only) and FMVSS 202 (Head Restraints) may possibly have related effects. It is conceivable that there is a relation between these two Standards which influences possible effectiveness. In the evaluation of FMVSS 207, it is assumed that the other Standards are equally effective on 2-door and 4-door cars. FMVSS 207 (Seat Back Locks, Only) applies to 2-door passenger vehicles. Thus, in the evaluation of seat back restraints, 4-door cars may be regarded as a "control group." There is the possibility that if another Standard or industry-introduced safety measure had a significantly different effect in 2- and 4-door cars in frontal crashes, it may act as a confounding influence on the evaluation of the Standard. For example, General Motors and Chrysler introduced collapsible steering columns in 1967, and Ford modified the steering wheel in 1967 and introduced collapsible columns in 1968. The effects of collapsible columns may be different in 2-door and 4-door vehicles and also ultimately related to the presence of seat back locks in the 2-door vehicles (at least as far as driver injuries are concerned). Possible confounding factors on the evaluation of the Standard are discussed in Section 3.1.3.

1.2 Objective and Purpose

The principal objective of this analysis is to determine if any effects of seat back locks on fatalities and injury avoidance can be determined from the statistical analyses of mass accident data from:

- Texas 1972-1974
- North Carolina 1973-1975
- New York 1974.

Other objectives are (1) to analyze the fatality rate of front and rear seat occupants, using the Fatal Accident Reporting System (FARS) data, to determine whether the presence of seat back locks increases the possibility of rear seat occupants being trapped and killed in panic situations where quick exit from the car is required, and (2) to analyze National Crash Severity Study (NCSS) accident data on seat failure and driver injury.

1.3 Scope of Analysis

- The analysis of the effects of seat back locks on injury avoidance is primarily concerned with fatalities and injuries to drivers.
- In injury avoidance evaluation the statistical analyses rely on a comparison of 2-door and 4-door Pre- and Post-Standard cars.
- Mass accident data from Texas (3 years), North Carolina (3 years) and New York (1 year) are used.
- The analysis of the effects of seat back locks on rear seat occupant fatalities uses the FARS data for the years 1975 through 1978.
- The analysis of driver injury and seat failures uses NCSS computerized accident data from April 1, 1978 through 1979.

1.4 Approach

The statistical evaluation of the effects of FMVSS 207 is here limited to three specific studies:

1. Injury Analysis for Seating Systems, Using State Accident Data.
2. Rear Occupant Fatality Analysis, Using FARS Data.
3. NCSS Data on Driver Injury and Seat Failure.

The first and major study is concerned with determining if the self-locking seat back devices are an important deterrent to fatalities and injuries of drivers. The second study deals with assessing whether the seat back locks may trap rear seat passengers in severe accidents and increase the risk of death to rear passengers in 2-door cars. The third study briefly reviews limited computerized NCSS data on driver injury and seat failure.

The hypothesis investigated in the first analysis is that drivers of 2-door cars will benefit from reduced injuries in frontal collisions by having the seat back fixed, rather than free to dynamically rotate forward, thus forcing the driver and the passenger(s) into the steering wheel and/or dash panel in front of them. Because there were many other injury reducing Standards introduced at approximately the same time as FMVSS 207, as well as various changes in the vehicles and in sales trends,it is assumed that the degree to which seat back locks are effective can be determined by comparing the difference in the changes of injury rates between 2-door cars and 4-door cars before and after the implementation of FMVSS 207. Specifically, one would expect drivers in 2-door cars to have a slightly greater injury reduction than drivers in 4-door cars, if, in fact, the seat back locks are effective. However, two factors deserve mention at this point. First, the analysis is restricted to drivers in frontal collisions only. Second, if other FMVSS were differentially applied or had significantly greater effectiveness in 2-door or 4-door cars, then any difference in the reduction of injury rates could be attributed to these factors as well as to the presence of seat back locks.

The rear occupant fatality analysis considers the possibility of rear seat occupants becoming trapped due to the inability to release seat back locks in panic-producing situations such as post-crash fires or immersion, where quick exit is essential. It would appear from the analysis that trapping is not an important effect; rather, seat back locks appear to have a beneficial effect of containing rear seat occupants in the rear seat area during a collision and preventing them from being projected into the front seat area, where they might strike objects after having gained momentum.

1.5 Limitations of the Study

This study does not provide a measure of the overall effectiveness of all aspects of FMVSS 207. It is limited to a consideration of the effects of the self-locking restraining devices for folding seat backs in 2-door passenger cars.

As was pointed out previously, seat back locks were introduced in the model years 1967-1968 in 2-door cars. Seat back locks are the only requirements mandated by FMVSS 207 which do not apply to 4-door cars as well and, hence, the Pre- and Post-Standard 4-door vehicles may be regarded as a control group in the evaluation of seat back locks.

It should also be noted that the other major aspect of FMVSS 207, specifications for seating system strengths, would be difficult to evaluate for two reasons. First, it appears unlikely that the strength of seating systems has changed significantly over the past 30 years. Second, unlike seat back locks, these specifications apply equally to both 2-door and 4-door vehicles.

1.6 Outline of the Report

Section 2 of this report summarizes the analyses performed in the evaluation of the effectiveness of FMVSS 207 with regard to seat back locks. It includes a discussion of the measure of effectiveness; the estimated effectiveness of the Standard; confidence limits on the estimated effectiveness; overall success of the evaluation and the credibility of the analysis. Also included in Section 2 are various comparisons of results and the final conclusions, findings and recommendations obtained from the analysis.

In Section 3, the detailed analyses of the data are described. The Appendices include relevant data in the form of completely cross-classified tables (Appendix A), and a complete description of resultant models (Appendix B) for the Texas, New York and North Carolina accident data samples, as well as effectiveness results for observed unadjusted data (Appendix C) and a description of the effectiveness computations and error estimation procedure (Appendix D).

1.7 References for Section 1

1. Ball, J.T., J.C. Reidy and G.M. Northrop. *Final Design and Implementation Plan for Evaluating the Effectiveness of FMVSS 202: Head Restraints, and FMVSS 207: Seating Systems*, DOT HS 803 392, National Technical Information Service, Springfield, Virginia, 1977.

2. Northrop, G.M., J.T. Ball, D. Bancroft and J.C. Reidy. *Methodologies for Nine Federal Motor Vehicle Safety Standards: FMVS 105, 108, 122, 202, 207, 213, 221, 222,* DOT HS 803 388, National Technical Information Service, Springfield, Virginia, 1977.

2.0 SUMMARY OF ANALYSES PERFORMED FOR FMVSS 207

2.1 Measures of Effectiveness

The effectiveness measure used for evaluating the effects of seat back locks on driver injury is defined as follows.

$$\left[\begin{array}{c}\text{Effectiveness}\\ \text{of Seat Back}\\ \text{Locks}\end{array}\right] = \left[1 - \left\{\frac{\begin{array}{c}\text{Injury Rate for Drivers of}\\ \text{Post-Standard, 2-Door Cars}\end{array}}{\begin{array}{c}\text{Injury Rate for Drivers of}\\ \text{Pre-Standard, 2-Door cars}\end{array}} \times \frac{\begin{array}{c}\text{Injury Rate for Drivers of}\\ \text{Pre-Standard, 4-Door Cars}\end{array}}{\begin{array}{c}\text{Injury Rate for Drivers of}\\ \text{Post-Standard, 4-Door Cars}\end{array}}\right\}\right] \times 100$$

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was also examined by testing the hypothesis that the presence of seat back locks increased the probability of rear seat occupants of 2-door, Post-Standard cars being killed as a result of their being trapped by the seat back lock in panic situations. Empirically, this "trapping" effect was defined as:

$$\left[\begin{array}{c}\text{Trapping}\\ \text{Effect}\end{array}\right] = \left[\left\{\frac{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Post-Standard, 2-Door Cars}\end{array}}{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Pre-Standard, 2-Door Cars}\end{array}} \times \frac{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Pre-Standard, 4-Door Cars}\end{array}}{\begin{array}{c}\text{Fatality Rate for Occupants}\\ \text{of Post-Standard, 4-Door Cars}\end{array}}\right\} - 1\right] \times 100$$

Positive values indicates that a trapping effect may be occurring.

2.2 Estimated Effectiveness of FMVSS 207

FMVSS 207 applies to passenger cars, multipurpose passenger vehicles, trucks and buses. The main impact of the Standard was to require a self-locking restraining device for folding seats and seat backs. Other requirements relate to the strength of seats and seat track devices. Because seat back locks were installed on two-door passenger cars generally in the 1968 model year, the analysis basically focuses on the change in the frequency of injury to drivers of two-door cars between Pre-Standard and Post-Standard models. Secondary investigations (1) study the possibility of increased fatalities of rear seat passengers due to being trapped and (2) analyze NCSS data on seat failures. The major analysis springs from the hypothesis that with seat back locks in a frontal collision, (a) the front seat passenger will not have an additional load or impact from the seat back, and (b) items in the back seat, particularly passengers, will not be thrown against the front seat passengers. The second analysis stems from speculation that seat back lock releases are sometimes difficult to

locate and operate, especially in panic situations, and may "trap" rear seat passengers, which would be extremely dangerous in situations where fire, explosion or immersion is a post-crash event. The third study is a very limited investigation of the association of driver injury with the failure of seat back locks and other aspects of seat failure using NCSS data.

2.2.1 Effectiveness of FMVSS 207 in Reducing Driver Injuries

The effectiveness of seat back locks for reducing the injury risk of drivers in 2-door passenger cars involved in frontal collisions was evaluated using mass accident data as summarized in Table 2-1. Thus, the effectiveness results are based on more than 600,000 cases from Texas, New York and North Carolina, covering seven state-years of accident data.

TABLE 2-1

MASS ACCIDENT DATA USED TO EVALUATE THE EFFECTIVENESS OF SEAT BACK LOCKS

State	Year	Sample Size	Total
Texas	1972	156,943	
	1973	158,897	459,228
	1974	143,388	
New York	1974	65,593	65,593
North Carolina	1973	27,345	
	1974	26,707	82,463
	1975	28,411	
Total Cases			607,284

Before effectiveness values were computed, the data were smoothed by fitting hierarchical, log-linear models to contingency tables composed of the variables Injury, PrePost, Vehicle Body Style (2-door or 4-Door) and selected control variables for each state-year of data. Three distinct injury dichotomies were used: KA/BCO, KAB/CO and KABC/O. Modeling served the dual purpose of smoothing the data by removing random variability due to small cell frequencies, and of revealing the strength and pattern of various interactions among the variables comprising the contingency tables.

The smoothed data were then adjusted (standardized) to allow for the direct comparison of injury rates. Adjustment of the data was necessary in order to insure that the overall effectiveness estimates were not affected by different

distributions of Pre- and Post-Standard, 2-door and 4-door vehicles across different levels of control variables.

The effectiveness results obtained are summarized in Table 2-2 and Table 2-3 for observed, unadjusted mass accident data and smoothed, adjusted data, respectively. Effectiveness percentages are given together with an associated standard deviation and confidence interval for three injury dichotomies (KA/BCO, KAB/CO and KABC/O) for each state and year analyzed.* On the average, the net impact of modeling and adjustment was to increase the value of effectiveness estimates by roughly two to three percent.

The effectiveness values computed for the smoothed, adjusted data are most often negative. In Texas (the largest sample), effectiveness ranged from 4.9 percent to -12.7 percent for KA/BCO; -1.3 percent to -10.3 percent for KAB/CO; and -0.7 percent to -8.3 percent for KABC/O. The effectiveness values computed from the New York 1974 sample were negative for all three injury dichotomies (-7.2 percent to -17.9 percent). In North Carolina, the effectiveness was negative in 1973 and 1974 for all three injury dichotomies and positive in 1975.**

The results of the analyses are consistent with the null hypothesis that the introduction of seat back locks in 2-door passenger cars had no effect on the injury risk to drivers in these cars. That is, the results do not demonstrate that this aspect of the Standard has been effective in reducing injury.

From Tables 2-2 and 2-3, the following observations are made.

- A comparison of the effectiveness results obtained for the observed (raw) unadjusted with the smoothed (modeled) adjusted data shows that usually a greater effectiveness is obtained with the smoothed adjusted data. In the observed data, the reduction in injury rates from Pre-Standard to Post-Standard cars is greater in 4-door cars than in 2-door cars. Thus, modeling and adjustment to remove confounding effects does increase effectiveness; however, for most samples, negative values remain.

- The variability in results among years is greater in North Carolina with the small data base than in Texas with the much larger number of cases.

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*Definitions of injury levels are: K = killed; A = severely injured; B = moderately injured; C = minor injuries; O = no injury.

**In general, negative effectiveness values do not allow rejection of the null hypothesis that seat back locks do not reduce the incidence or severity of injuries in the broad class of frontal crashes between two passenger automobiles. Negative effectiveness values do <u>not</u> imply that the Standard is causing injuries.

TABLE 2-2

SUMMARY OF PERCENT EFFECTIVENESS FOR OBSERVED UNADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval	
					From	To
KA	Texas	1972	5.1	6.1	-4.9	15.1
		1973	-6.7	7.2	-18.5	5.1
		1974	-2.8	8.0	-16.0	10.3
	New York	1974	-27.4	9.7	-43.2	-11.5
	North Carolina	1973	-49.8	24.0	-89.8	-9.8
		1974	-29.2	22.2	-65.7	7.3
		1975	20.1	14.6	-3.8	43.9
	Texas 1965-1971 Model Year Cars	1972	4.4	7.8	-8.3	17.17
		1973	-2.5	9.0	-17.3	12.3
		1974	3.2	9.8	-12.9	19.3
KAB	Texas	1972	-3.2	3.6	-9.1	2.6
		1973	-1.0	3.5	-6.8	4.8
		1974	-16.3	4.5	-23.6	-9.0
	New York	1974	-14.6	4.5	-22.0	-7.3
	North Carolina	1973	-6.8	9.1	-21.6	8.1
		1974	-26.9	11.1	-45.0	-8.7
		1975	12.0	7.7	-0.7	24.7
	Texas 1965-1971 Model Year Cars	1972	-1.8	4.5	-9.2	5.5
		1973	3.4	4.4	-3.9	10.6
		1974	-15.4	5.7	-24.8	-6.0
KABC	Texas	1972	-2.3	2.9	-7.1	2.5
		1973	1.2	2.8	-3.4	5.9
		1974	-12.5	3.5	-18.2	-6.7
	New York	1974	-8.3	3.1	-13.4	-3.2
	North Carolina	1973	-9.7	6.9	-21.0	1.5
		1974	-18.9	7.5	-31.2	-6.5
		1975	1.2	6.2	-9.1	11.4
	Texas 1965-1971 Model Year Cars	1972	-0.7	3.6	-6.7	5.2
		1973	6.0	3.5	0.3	11.8
		1974	-10.7	4.5	-18.1	-3.4

TABLE 2-3

SUMMARY OF PERCENT EFFECTIVENESS FOR SMOOTHED ADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval	
					From	To
KA	Texas	1972	4.9	6.1	-5.1	14.9
		1973	-12.7	7.6	-25.0	-0.3
		1974	1.9	7.7	-10.7	14.6
	New York	1974	-17.9	8.9	-32.5	-3.3
	North Carolina	1973	-44.4	23.5	-82.9	-5.9
		1974	-19.0	20.9	-53.3	15.2
		1975	26.5	13.7	4.0	49.0
	Texas 1965-1971 Model Year Cars	1972	6.0	7.7	-6.6	18.5
		1973	-5.3	9.3	-20.5	9.9
		1974	5.0	9.7	-10.8	20.9
KAB	Texas	1972	-1.3	3.5	-7.1	4.4
		1973	-3.5	3.6	-9.4	2.5
		1974	-10.3	4.3	-17.4	-3.3
	New York	1974	-12.1	4.4	-19.4	-4.9
	North Carolina	1973	-3.7	8.8	-18.1	10.7
		1974	-19.9	10.6	-37.4	-2.5
		1975	14.9	7.5	2.6	27.1
	Texas 1965-1971 Model Year Cars	1972	-0.4	4.5	-7.7	6.9
		1973	1.3	4.5	-6.1	8.7
		1974	-10.3	6.5	-19.4	-1.3
KABC	Texas	1972	-1.6	2.9	-6.3	3.1
		1973	-0.7	2.9	-5.4	4.1
		1974	-8.3	3.4	-13.9	-2.6
	New York	1974	-7.2	3.1	-12.2	-2.1
	North Carolina	1973	-7.9	6.8	-19.0	3.3
		1974	-14.6	7.4	-26.6	-2.5
		1975	5.6	6.0	-4.2	15.4
	Texas 1965-1971 Model Year Cars	1972	0.3	3.6	-5.6	6.2
		1973	4.7	3.6	-1.2	10.5
		1974	-7.1	4.4	-14.3	0.0

- A reduced sample for Texas was created by including only 1965-1971 model year cars. This eliminates very old cars, includes only model years fairly close to the time of Standard implementation,and reduces the effects of the market shift from 4-door cars to 2-door cars which took place over an extended period. The results, however, were about the same, indicating that the inclusion of very old and very new cars in the Texas 1972-1974 sample did not confound the results.

2.2.2 Analyses for Trapping

The analysis of a potential trapping effect for rear seat occupants in Post-Standard 2-door passenger cars was conducted using fatal accidents involving fire, explosion or immersion derived from the Fatal Accident Reporting System (FARS) for 1975, 1976, 1977 and 1978. The results are summarized in Table 2-4. The results do not support the hypothesis that seat back locks increase the possibility of trapping a rear seat occupant in a panic situation,resulting in increased fatalities. If this were so, one would expect positive values for rear seat occupants and possibly negative values for front seat occupants. Contrary to this expectation, there is an estimated 19 percent decrease in the Pre- to Post-Standard ratio of rear seat occupant fatality rates corresponding to 2-door, Post-Standard vehicles while a 4 percent decrease occurs for front seat occupants. It can be speculated that the locked front seat back may act as a restraint on the forward movement of rear seat passengers during a crash, reducing the likelihood of fatal or serious injury. This beneficial effect is perhaps more important than a possible trapping effect.

TABLE 2-4

RESULTS FOR FRONT AND REAR SEAT OCCUPANTS TO EVALUATE TRAPPING IN FIRE/EXPLOSION/IMMERSION ACCIDENTS

Occupant Location	Weighted Change in Post Standard/Pre-Standard Fatality Ratio
Rear Seat	- 19 % N = 513
Front Seat	- 4 % N = 3086
Total	N = 3599

2.2.3 Occupant Injury and Seat Failures

An analysis of a limited sample of computerized National Crash Severity Study (NCSS) data indicated that the probability of avoiding injury is three times greater when no seat failure occurs. Seat failure was defined to include any seat deformation as well as failure of the seat adjuster, track and lock. Fatal or serious injury occurs about five times more often with seat failure. The NCSS seat failure rates were 2.4 percent in Pre-Standard cars and 3.7 percent in Post-Standard cars. It should be noted that seat failure occurred in only four percent of the NCSS cases. Seat failure tends to occur primarily in very violent crashes, where the failure of the seat is likely to be only one of many possible mechanisms causing or contributing to death or serious injury.

2.3 Evaluation of the Driver Injury Analysis

2.3.1 Overall Success of the Analysis

The analysis of the effects of seat back locks on driver injuries does not support the hypothesis that seat back locks reduce injury risk to drivers of 2-door passenger cars involved in frontal collisions. The observed, unadjusted data with confounding effects has an injury reduction that is greater in 4-door Post-Standard cars than in 2-door Post-Standard cars, resulting in negative effectiveness. The process of modeling and adjusting the data to remove confounding effects increases the computed effectiveness. However, with the single exception of results for one year (North Carolina 1975), the effectiveness is negative or near zero.

It is reasonable to infer that the effect of seat back locks on driver injury risk in 2-door cars is at most very small and difficult to quantify, given the potential for confounding effects from the implementation of other Standards implemented about the same time; the changing distribution of 2-door and 4-door cars in the automotive population; vehicle weight differences among 2-door and 4-door cars; and potential differences of age, sex, socioeconomic and personality factors among drivers of 2-door and 4-door cars.

2.3.2 Limitations of the Driver Injury Analysis

The analysis of the driver injury reduction effect of FMVSS 207 is limited in the following ways.

1. State mass accident data do not indicate whether injury was due to the seat back itself, or to other mechanisms.

   Obviously, the conclusive determination of this information would be virtually impossible in most accident situations.

2. There was a large shift from 4-door to 2-door cars during the period considered in this analysis. It is apparent that if this trend had been ignored in the analysis, any relative changes in injury rates could be attributed to the market trend rather than to seat back locks. This effect is controlled for but not entirely eliminated by the modeling and adjustment process that was used with the data.

3. Only driver injuries have been studied. Insufficient data were available to analyze the effectiveness of seat back locks for front seat passengers.

4. Mass accident data recording techniques result in missing data and the misclassification of data.

   It is known that the police assignment of injuries to the intermediate KABCO is somewhat subjective and ambiguous, particularly for the B, C, and O levels. Missing information for some variables has prevented some useful comparisons between states from being made. In some cases, certain types of information are not collected, e.g., vehicle weight in Texas. Data limiations such as this have been partially offset by using make/model/year information.

5. The analytic approach imposes some practical and theoretical constraints.

   The use of categorical data analysis techniques limits the modeling of smooth relationships between factors, e.g., relations between driver age and injury severity.

2.3.3 Credibility of the Analysis

The credibility of the analysis is quite high even considering the limitations noted in Section 2.3.2. More than 600,000 cases of driver involvement in frontal crashes were studied, and the cars were rather evenly divided among 2-door and 4-door cars and Pre-Standard and Post-Standard cars, assuring a large sample in each cell. The analysis was carried out in three states of widely divergent locations and somewhat different economic and demographic characteristics, as well as driving habits.

2.4 Evaluation of the Rear Seat Occupant Analysis

2.4.1 Overall Success of the Analysis

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was addressed by the analysis. The results, while based on a small number of cases, suggest that any effect due to entrapment is outweighed by the beneficial effect of a rigid seat back confining rear seat passengers to the rear area during a collision, thus reducing the likelihood of serious or fatal injury.

2.4.2 Characteristics and Limitations of the Rear Seat Occupant Analysis

Two important aspects should be pointed out:

1. This analysis was carried out on the basis of the FARS data for the period 1975-1978, and FARS is a census of fatal accidents for that period.

2. Using police reported accident data, it is not possible to determine the cause of death or other factors which might indicate the importance of the seat back lock.

2.4.3 Credibility of the Analysis

The credibility of the results is as high as practicable, because the analysis is based on the entire FARS census and not on a sample. A trapping effect of -19 percent was determined, which is the opposite of what would be expected if there were an increase in trapping. From this, it would appear that seat back locks are possibly beneficial to rear seat passengers, even in fire/explosion/immersion situations, by confining them to the rear seat and keeping them from being thrown into the front seat region, where they might strike the windshield, windows and supports, the dash, and front seat occupants. Also, because of the seat back locks, the occupants of rear seats in 2-door cars are less likely to be ejected through open front windows or doors.

3.0 ANALYSIS OF MASS ACCIDENT DATA AND NCSS DATA

Overview

This section contains a detailed description of two analyses performed on mass accident data and a brief examination of NCSS data. The analyses described in this section include:

- 3.1 Analysis of Driver Injuries
- 3.2 Analysis of Rear Seat Occupant Fatalities
- 3.3 Analysis of NCSS Data on Seat Intrusion

The first analysis is the principal effort for studying the effectiveness of seat back locks in 2-door passenger cars. The analysis contains a discussion of the analytic approach; a description of the data files used and how they were derived; and a step-by-step presentation of the analysis through the determination of effectiveness and estimation of errors for FMVSS 207. More briefly, the second analysis investigates the question of trapping rear seat occupants, while the third analysis examines the relation between driver injury and seat failure as determined from a portion of NCSS accident data.

3.1 Analysis of Driver Injuries

3.1.1 Analysis Approach

The purpose of this analysis is to assess whether the requirement for seat back locks in 2-door passenger cars reduces the severity or frequency of injuries to drivers. This effect has been investigated by using state accident data to analyze the injury characteristics of drivers in passenger car frontal crashes.

As was outlined in Section 1.1, FMVSS 207 went into effect on 1 January 1968. Prior to the implementation of the Standard, only General Motors had included (in 1967) seat back locks on all their 2-door models. There also were self-locking seat back restraints on some types of foreign cars implemented over a period of years prior to 1967. However, foreign cars are excluded from the sample.

To address the question of whether seat back locks reduce the frequency or severity of injury to front seat occupants, a comparison is made between drivers of 2- and 4-door cars before (Pre) and after (Post) the Standard took effect. The 4-door cars received the same modifications (which were mandated by other Standards that went into the effect at roughly the same time as FMVSS 207) as were made in 2-door cars, except the seat back lock. Thus, by looking at the changes in injury distribution of drivers of 2-door cars before and after the implementation of the Standard and comparing this with the analogous data for drivers of 4-door models, one might hope to assess the impact of the Standard on injury reduction. In effect, the 4-door vehicles are being treated as a control group.

There is a difficulty in a straightforward approach to the analysis outlined above caused by a rather large change in the relative sales of 2 and 4-door cars. The following table presents the distribution of domestic factory sales by vehicle type.

TABLE 3-1

DOMESTIC FACTORY SALES BY VEHICLE TYPE
(Percent)

Year	Vehicle Type		
	2-Door	4-Door	Chassis/Convertibles
1966	45.3	50.0	4.7
1967	48.2	47.6	4.2
1968	50.8	46.0	3.2
1969	51.9	45.6	2.5
1970	53.6	45.0	1.4
1971	53.2	45.7	1.1
1972	54.3	45.0	0.7

Source: Automobiles Facts and Figures Compiled Annually by Motor Vehicle Manufacturers Association of U.S. [1]

It is apparent that there has been a marked shift away from 4-door cars and, unless controlled for, any relative differences in injury rates may be attributable to the market shift rather than to seat back locks.

CEM's analytic approach to evaluating FMVSS 207 has three major aspects:

- Definition of effectiveness measures.
- Smoothing of the data to remove chance variation.
- Adjustment of the data to control for differences of the injury rates that are not due to FMVSS 207.

The basic variables used in the analysis are Pre/Post, 2-door/4-door, and injury severity; other variables are selected for adjusting and/or modeling the data. Driver injury distributions between Pre- and Post-Standard 2- and 4-door cars are not directly comparable without adjustment. There are differences among the four classes in the distribution of other variables such as vehicle weight, driver age and driver sex. In order to address the question of how many (driver) injuries were avoided due to seat back locks on 2-door, Post-Standard cars, the data have to be adjusted for these differences. Once this is done, the driver injury distribution of other classes of accidents can be directly compared to the driver injury distribution for all 2-door car accidents.

With the above comments in mind, the analysis of the effectiveness of FMVSS 207 is carried out in the following steps:

1. Select the full mass accident data base. The data bases analyzed are Texas 1972-1974, North Carolina 1973-1975 and New York 1974.
2. Extract the partial data set to be directly used in evaluation of the Standard. The partial data set consists of drivers in passenger cars involved in frontal impact collisions.
3. Define variables to be considered for modeling and adjustment. In addition to Model Year Class (Pre/Post), Vehicle Body Style (Style) and Driver Injury (Injury), all available variables that might account or control for possible confounding effects and random variability of the data are considered for modeling and adjustment.
4. Apply the variable selection procedure. From the group of potential variables, at most four can be selected for modeling and adjustment. This reflects the limitation of a maximum of seven variables in the modeling procedure. The variable selection procedure consists of ranking all potential variables according to the strength of their interactions with Prepost, Style and Injury and choosing those variables with the highest degree of interaction.

5. Model the data defined by the table, Injury x Pre/Post x Style x $Variable_1$ x $Variable_2$ x ... $Variable_n$, using the log-linear modeling routine in the Biomedical Computer Programs P-Series.[2] The purpose of modeling is to remove random variability and smooth the data. Modeling also reveals the strengths of interactions among variable groups. Modeling is carried out separately for 3 injury dichotomies (KA x BCO, KAB x CO, KABC x O).

6. Adjust the smoothed data to allow for the direct comparison of injury rates. Adjustment is necessary in order to insure that the overall effectiveness estimates will not be affected by a different distribution of 2-door and 4-door vehicles across all levels of the relevant pre-crash factors identified in the variable selection procedure.

7. Compute the effectiveness of the Standard for each state-year data subset and compare results. The effectiveness measure which is used in this analysis is a ratio of the change (Pre vs. Post) in injury rates for drivers of 4-door cars relative to the change (Pre vs. Post) for drivers of 4-door cars. If P_{ij} are defined as in Table 3-2, then the effectiveness is computed as follows.

$$E = \left[1 - \left\{\frac{P_{21}}{P_{11}} x \frac{P_{12}}{P_{22}}\right\}\right] x \ 100$$

An error estimate of each effectiveness computation is made.

TABLE 3-2

CLASSIFICATION OF DRIVER INJURY RATES

Condition	2-Door	4-Door
Pre-Standard	P_{11}	P_{12}
Post-Standard	P_{21}	P_{22}

8. Repeat Steps 5-7 for data that include only drivers in passenger cars with model years from 1965 through 1971 (i.e., close to the time of Standard implementation) and evaluate any differences in the effectiveness and error estimate.

9. If positive effectiveness is found, extrapolate the results based on Texas, North Carolina and New York to nationwide estimates of the number of injuries avoided assuming all 2-door cars have seat back locks compared with no 2-door having seat back locks.

3.1.2 Data Characteristics and Variable Selection

The data characteristics and variable selection for each state are presented separately in this subsection. The five generic tables that document each data set are:

- Relation of partial data set to full data base.
- Univariate frequency distribution of relevant variables.
- Injury rates for Pre/Post Standard x 2-door/4-door vehicle x relevant variables.
- Chi-squares of interaction terms of variables considered for modeling and adjustment.
- Completely cross-classified contingency table of data prior to modeling (Appendix A).

Texas 1972, 1973, 1974

The size of the seat back lock drivers-only data set relative to the entire 1972-1974 Texas accident data base can be characterized by noting the fraction of accidents, vehicles and fatalities contained in the data set as given in Table 3-3. The low fatality rates in the Texas partial data sample (and also in North Carolina and New York) result from the screening procedure used to establish a data set that might reflect the effects of adding seat back locks. The partial data set excluded vehicles that overturned or had run off the road. Only drivers were included. Since average occupancy is 1.6 persons per vehicle, a significant number of other occupants are excluded. Foreign cars were excluded, because many foreign manufacturers had seat back locks before 1968. Convertibles were not included as passenger cars and passenger cars towing anything were excluded. All of the above factors tend to lessen the number of fatalities and fatal accidents included in the partial data set.

TABLE 3-3

ACCIDENTS, VEHICLES AND FATALITIES IN 1972-1974 TEXAS DATA BASE

Year	Variable	Full Data Base	Partial Data Set	Percent
1972	Accidents	432,998	125,555	29.0
	Vehicles	744,699	156,943	21.1
	Fatalities	3,688	362	9.8
1973	Accidents	464,226	127,779	27.5
	Vehicles	800,545	158,897	19.9
	Fatalities	3,692	334	9.1
1974	Accidents	434,194	114,711	26.4
	Vehicles	747,834	143,388	19.2
	Fatalities	3,046	261	8.6

Specifically, the partial data set was derived by selecting cases that satisfied the following values of the screening criteria:

- Vehicle Type = Passenger Car.
- Point of Impact = Front.
- Accident Type = Frontal Collision with:
  1. another motor vehicle,
  2. a parked car, or
  3. a fixed object.
- Manner of Collision - Between Two Motor Vehicles, or Single Vehicle Striking Fixed Object.
- Number of Vehicles in Accident = 1 or 2.
- Vehicle Make and Model = "Domestic."
- Vehicle Body Style - 2-door or 4-door Passenger Car.
- Vehicle Model Year is known.
- "Drivers" of parked cars are eliminated.

The univariate frequencies of some key variables in the Texas 1972-1974 driver-only 10 percent sample are given in Table 3-4. The 10 percent random sampling yielded 49,355 cases for the three years. The univariate distributions are shown for each year and the three years combined. The table contains few surprises and only a few remarks concerning the data will be noted. Only 2.3 percent of the drivers suffered fatal or serious injury. This distribution of driver injury indicates that a KABC vs. O injury dichotomy may be required to yield interpretable results, since almost 89 percent of the drivers are listed as uninjured. The percentage of Pre-Standard cars shifts from 44 percent in 1972 to 29 percent in 1974, with an overall 36 percent for the three years. This percentage is considerably higher than in the North Carolina and New York data bases and reflects, of course, the closer overall proximity in time to the Standard implementation date in Texas. The Model Year Category variable indicates that 63 percent of the vehicles have a model year between 1965 and 1971, within reasonably close proximity of Standard implementation. The distribution of the overall sample between 2-door and 4-door cars is 56 percent and 44 percent, respectively.

Injury rates (KABC percentages) and the number of drivers on which the rates are based are given in Tables 3-5, 3-6 and 3-7 for the Texas 1972, 1973 and 1974 drivers-only 10 percent sample. The rates are given for each category of all variables considered for modeling and are depicted separately for 2-door/4-door cars and Pre/Post Standard.

TABLE 3-4

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY TEXAS 10 PERCENT SAMPLE

Variable	Category	1972		1973		1974		Total: 1972-1974	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
Driver Injury	K	27	0.2	34	0.2	24	0.2	85	0.2
	A	432	2.5	350	2.1	248	1.6	1,030	2.1
	B	923	5.4	866	5.1	950	6.1	2,739	5.6
	C	591	3.5	599	3.5	561	3.6	1,751	3.5
	O	14,991	88.4	15,055	89.1	13,704	88.5	43,750	88.6
Model Year Class	Pre	7,442	43.9	6,004	35.5	4,441	28.7	17,887	36.2
	Post	9,522	56.1	10,900	64.5	11,046	71.3	31,468	63.8
Vehicle Body Style	2-Door	9,198	54.2	9,529	56.4	9,046	58.4	27,773	56.3
	4-Door	7,766	45.8	7,375	43.6	6,441	41.6	21,582	43.7
City Size	Rural	1,373	8.1	1,309	7.7	1,051	6.8	3,733	7.6
	LT 2,500	445	2.6	417	2.5	413	2.7	1,275	2.6
	2,500- 5,000	389	2.3	395	2.3	337	2.2	1,121	2.3
	5,000- 10,000	679	4.0	693	4.1	623	4.0	1,995	4.0
	10,000- 25,000	1,401	8.3	1,437	8.5	1,344	8.7	4,182	8.5
	25,000- 50,000	908	5.4	928	5.5	882	5.7	2,718	5.5
	50,000-100,000	2,173	12.8	2,265	13.4	2,018	13.0	6,456	13.1
	100,000-250,000	1,273	7.5	1,261	7.5	1,136	7.7	3,720	7.5
	GT 250,000	8,323	49.1	8,199	48.5	7,633	49.3	24,155	48.9
Road Classification	Interstate	1,635	9.6	1,718	10.2	1,433	9.3	4,786	9.7
	U.S. & State	5,039	29.7	4,818	28.5	4,446	28.7	14,303	29.0
	Farm to Market	710	4.2	742	4.4	663	4.3	2,115	4.3
	County Road	348	2.1	327	1.9	304	2.0	979	2.0
	City Street	9,202	54.2	9,261	54.8	8,623	55.7	27,086	54.9
	Turnpike	30	0.2	38	0.2	18	0.1	86	0.2
Weather	Clear-Cloudy	14,239	83.9	13,739	81.3	12,895	83.3	40,873	82.8
	Rain	2,549	15.0	2,929	17.3	2,415	15.6	7,893	16.0
	Snow	64	0.4	130	0.8	35	0.2	229	0.5
	Fog	108	0.6	99	0.6	135	0.9	342	0.7
	Dust/Smoke	4	0.0	7	0.0	7	0.0	18	0.0
Accident Type	Collision w MV	14,709	86.7	14,552	86.1	13,308	85.9	42,569	86.3
	Coll.w Prkd Car	870	5.1	922	5.5	859	5.5	2,651	5.4
	Coll.w Fixd Obj	1,385	8.2	1,430	8.5	1,320	8.5	4,135	8.4
Light Condition	Daylight	12,453	73.4	12,413	73.4	11,248	72.6	36,114	73.2
	Dawn	73	0.4	65	0.4	103	0.7	241	0.5
	Dark-No Lights	2,981	17.6	2,890	17.1	2,545	16.4	8,416	17.1
	Dark-Lights	1,128	6.6	1,222	7.2	1,350	8.7	3,700	7.5
	Dusk	329	1.9	314	1.9	241	1.6	884	1.8
Road Surface Condition	Dry	13,371	78.8	12,765	75.5	12,250	79.1	38,386	77.8
	Wet	3,250	19.2	3,730	22.1	3,078	19.9	10,058	20.1
	Muddy	3	0.0	9	0.1	2	0.0	14	0.0
	Snowy	31	0.2	68	0.4	14	0.1	113	0.2
	Icy	309	1.8	332	2.0	143	0.9	784	1.6
TAD	1-2	10,341	62.1	10,750	64.7	9,844	64.8	30,935	63.8
	3-5	5,758	34.6	5,437	32.7	5,010	33.0	16,205	33.4
	6-7	545	3.3	433	2.6	349	2.3	1,327	2.7
	Missing	320	-	284	-	284	-	888	-
Driver Age	15-24	6,719	40.3	6,816	41.1	6,492	42.8	20,027	41.4
	25-54	7,654	45.9	7,582	45.7	6,710	44.2	21,946	45.3
	55-98	2,298	13.8	2,177	13.1	1,968	13.0	6,443	13.3
	Missing	293	-	329	-	317	-	939	-
Driver Sex	Male	11,077	65.8	10,929	65.1	9,826	63.9	31,832	65.0
	Female	5,768	34.2	5,869	34.9	5,541	36.1	17,178	35.0
	Missing	119	-	106	-	120	-	345	-

TABLE 3-4 (Continued)

Variable	Category	1972		1973		1974		Total: 1972-1974	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
Number of Occupants	One	15,839	93.4	15,882	94.0	14,533	93.3	46,254	93.7
	Two or More	1,125	6.6	1,020	6.0	953	6.2	3,098	6.3
Person Behind Driver	Yes	194	1.1	182	1.1	153	1.0	529	1.1
	No	16,761	98.9	16,712	98.9	15,325	99.0	48,798	98.9
	Missing	9	-	10	-	9	-	28	-
Vehicle Weight	LT 2690 lbs	1,594	9.6	1,563	9.4	1,422	9.3	4,579	9.5
	2690-4089 lbs	13,331	80.4	12,946	78.2	11,561	75.9	37,838	78.2
	GT 4090 lbs	1,658	10.0	2,039	12.3	2,249	14.8	5,946	12.3
	Missing	381	-	356	-	255	-	992	-
Number of Vehicles	One	2,238	13.2	2,343	13.9	2,169	14.0	6,750	13.7
	Two	14,726	86.8	14,561	86.1	13,318	86.0	42,605	86.3
Manufacturer	GM	9,588	56.5	9,535	56.4	8,592	55.5	27,715	56.2
	Ford	4,603	27.1	4,666	27.6	4,461	28.8	13,730	27.8
	Other	2,773	16.3	2,703	16.0	2,434	15.7	7,910	16.0
Model Year Category	Pre-Stnd-LT 65	3,740	22.0	2,670	15.8	1,781	11.5	8,191	16.6
	Pre-Stnd-GE 65	3,702	21.8	3,334	19.7	2,660	17.2	9,696	19.6
	Post-Stnd-LT 72	7,802	46.0	7,258	42.9	6,411	41.4	21,471	43.5
	Post-Stnd-GE 72	1,720	10.1	3,642	21.5	4,635	29.9	9,997	20.3
Total Number of Cases		16,964	-	16,904	-	15,487	-	49,355	-

TABLE 3-5

INJURY RATES FOR TEXAS 1972 DRIVER-ONLY 10 PERCENT SAMPLE

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Accident Type N = 16,964	Coll.w Motor Veh	11.2	9.1	10.9	7.6	2781	5169	3421	3338
	Coll.w Parked Car	14.5	13.9	18.1	18.8	227	201	309	133
	Coll.w Fixed Obj	35.3	31.3	31.6	19.2	337	483	367	198
Driver Age N = 16,671	15-24	13.6	11.0	11.2	8.5	1700	2684	1519	816
	25-34	13.6	10.8	15.6	8.5	736	1649	712	669
	35 or Older	15.3	12.1	14.7	8.9	848	1449	1766	2123
City Size N = 16,964	LT 5,000	20.7	23.4	21.8	16.5	411	675	559	562
	5,000-249,999	12.1	10.0	10.9	7.4	1277	2104	1652	1401
	GE 250,000	13.5	9.1	12.9	7.0	1657	3074	1886	1706
Vehicle Weight N = 16,583	LT 3000 lbs	14.1	13.2	15.3	14.2	1148	1314	692	226
	3000-3599 lbs	13.5	10.3	13.3	9.9	1456	2899	1904	950
	GE 3600 lbs	14.3	10.7	12.3	7.6	601	1563	1351	2479
TAD N = 16,644	1-2	3.6	2.3	3.4	1.6	1995	3508	2465	2373
	3-4	23.1	17.9	22.5	14.9	1099	1823	1280	1006
	5-7	67.3	57.8	65.6	60.3	202	422	262	209
Light Condition N = 16,964	Daylight	11.2	9.2	10.4	7.7	2312	4291	2983	2867
	Reduced Light	19.7	16.2	21.0	11.8	1033	1562	1114	802
Driver Sex N = 16,845	Male	13.0	9.9	12.8	7.5	2380	3730	2729	2238
	Female	16.5	13.4	14.8	10.5	935	2092	1325	1416
Road Surface Condition N = 16,964)	Dry	14.7	11.3	13.9	9.0	2622	4588	3288	2873
	Other	10.8	10.3	10.8	7.0	723	1265	809	796
Number of Vehicles N = 16,964	One	26.6	25.7	25.0	19.0	560	676	671	331
	Two	11.3	9.2	11.0	7.6	2785	5177	3416	3338
Manufacturer N = 16,964	GM	13.8	9.9	12.5	7.9	1614	3462	2336	2176
	Ford	13.9	12.6	15.4	8.8	1208	1534	1011	850
	Other	13.8	13.1	12.9	10.7	523	857	750	643
Road Classification N = 16,964	US/State/Interstate Hwy	15.9	12.8	14.5	10.3	1223 2	2413	1519	1549
	County/Farm Rd	18.9	16.7	18.3	13.4	201	360	273	224
	City Street	12.0	9.1	11.9	6.6	1921	3080	2305	1896
Number of Occupants N = 16,964	One	10.1	8.5	10.1	6.1	3070	5524	3780	3465
	Two or More	56.0	54.4	51.7	51.0	275	329	317	204
Weather N = 16,964	Clear/Cloudy	14.3	11.3	13.7	8.8	2810	4872	3497	3060
	Other	11.2	10.2	10.8	7.7	535	981	600	609
Person Behind Driver N = 16,955	Yes	64.2	61.6	68.0	56.8	53	54	50	37
	No	13.0	10.6	12.6	8.1	3291	5794	4045	3631

TABLE 3-6

INJURY RATES FOR TEXAS 1973 DRIVER-ONLY 10 PERCENT SAMPLE

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
City Size	LT 50,000	14.1	12.5	13.6	12.3	746	1919	1063	1451
N = 16,904	50,000-249,999	9.9	9.1	12.5	6.9	625	1390	703	808
	GE 250,000	13.2	9.9	11.3	8.2	1304	3545	1563	1787
Road Classification	US/State/Interstate Hwy	12.5	11.4	14.0	12.4	928	2700	1198	1748
N = 16,908	County/Farm Rd	14.9	13.8	20.2	12.1	168	413	223	265
	City Street	12.5	9.5	10.3	6.5	1579	3741	1908	2033
Driver Age	15-24	12.8	10.6	11.9	6.8	1370	3217	1268	961
N = 16,575	25-34	13.4	9.6	15.3	10.8	561	1825	577	767
	35 or Older	12.5	11.6	12.1	10.3	678	1717	1383	2251
Vehicle Weight	LT 3000 lbs	15.2	12.8	16.0	9.7	921	1550	582	248
N = 16,548	3000-3999 lbs	10.9	10.1	12.2	9.8	1445	4240	2320	2346
	GE 4000 lbs	13.8	8.4	7.7	8.8	189	960	310	1437
Manufacturer	GM	11.4	10.3	11.3	8.9	1276	4027	1861	2371
N = 16,904	Ford	14.8	10.7	14.3	10.5	1029	1846	830	961
	Other	11.1	10.7	12.5	9.8	370	981	638	714
Accident Type	Coll.w Motor Veh	9.7	8.6	9.5	7.8	2206	6013	2738	3595
N = 16,904	Coll.w Parked Car	18.6	18.8	16.7	11.5	199	271	269	182
	Coll.w Fixed Obj	32.2	26.7	32.6	30.2	270	570	322	268
Number of Occupants	One	9.9	8.3	9.6	6.9	2475	6494	3096	3817
	Two or More	47.0	50.3	48.5	51.5	200	360	233	229
N = 16,904									
Person Behind Driver	Yes	45.7	44.9	68.3	52.6	35	49	41	57
	No	12.2	10.2	11.6	8.8	2637	6800	3286	3989
N = 16,894									
TAD	1-2	3.2	2.7	3.2	2.1	1672	4296	2158	2624
N = 16,620	3-4	22.2	17.9	24.0	16.6	798	2036	939	1136
	5-7	62.2	58.7	66.5	65.7	172	409	173	207
Light Condition	Daylight	10.0	8.0	9.4	7.6	1892	4995	2399	3127
	Reduced Light	19.0	17.2	19.9	15.6	783	1859	930	919
N = 16,904									
Weather	Clear/Cloudy	13.2	10.6	12.5	9.6	2164	5555	2765	3255
N = 16,904	Other	10.6	9.9	11.5	8.6	511	1299	564	791
Road Surface Condition	Dry	13.3	10.7	13.0	9.7	1999	5163	2590	3013
	Other	10.8	9.8	10.0	8.6	676	1691	739	1033
N = 16,904									
Number of Vehicles	One	26.1	24.1	25.5	22.1	467	841	588	447
	Two	9.8	8.6	9.5	7.8	2208	6013	2741	3599
N = 16,904									
Driver Sex	Male	12.4	10.1	11.4	8.5	1885	4294	2262	2488
N = 16,798	Female	13.9	11.3	14.6	11.0	762	2532	1033	1542

TABLE 3-7

INJURY RATES FOR TEXAS 1974 DRIVER-ONLY 10 PERCENT SAMPLE

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
City Size	LT 50,000	15.7	14.1	14.2	10.9	528	1938	801	1383
N = 15,487	50,000-244,999	11.6	9.7	15.5	7.0	431	1448	542	783
	GE 250,000	14.6	10.2	12.4	8.9	1005	3696	1134	1798
Accident Type	Coll.w Motor Veh	11.4	8.9	10.9	7.4	1611	6145	2004	3548
N = 15,487	Coll.wParked Car	15.0	15.6	19.0	21.5	127	353	216	163
	Coll.w Fixed Obj	34.1	32.2	31.1	30.0	226	584	257	253
TAD	1-2	3.7	3.0	4.1	2.0	1208	4456	1574	2606
N = 15,203	3-4	27.0	20.4	26.2	19.3	610	2135	744	1086
	5-7	62.5	61.4	62.0	61.7	112	363	129	180
Vehicle Weight	LT 3000 lbs	15.8	14.0	13.5	11.3	717	1590	474	240
N = 15,232	3000-3999 lbs	13.4	10.6	13.8	9.8	1027	4257	1708	2128
	GE 4000 lbs	10.9	9.9	13.0	8.6	137	1173	207	1574
Driver Age	15-24	13.8	11.1	13.4	10.7	1002	3451	969	1070
N = 15,170	25-34	13.6	10.7	13.6	9.3	411	1870	403	774
	35 or Older	16.8	12.2	14.4	9.0	493	1659	1034	2034
Road Classification	US/State/Interstate Hwy	14.1	12.0	15.7	9.7	687	2736	873	1601
N = 15,487	County/Farm Rd	18.9	14.3	22.5	13.5	122	462	138	245
	City Street	13.9	10.3	11.7	8.7	1155	3884	1466	2118
Light Condition	Daylight	11.4	9.0	11.2	7.3	1370	5041	1781	3056
N = 15,487	Reduced Light	20.9	16.6	20.0	16.3	594	2041	696	980
Number of Vehicles	One	27.2	25.8	25.6	26.0	353	932	472	412
N = 15,487	Two	11.4	9.0	10.9	7.5	1611	6150	2005	3552
Road Surface Condition	Dry	15.6	11.6	14.3	9.7	1575	5603	1977	3095
N = 15,487	Other	9.0	9.7	11.2	8.4	389	1479	500	869
Weather	Clear/Cloudy	15.2	11.5	14.1	9.4	1655	5893	2085	3262
N = 15,487	Other	9.4	9.7	11.2	9.1	309	1189	392	702
Number of Occupants	One	11.4	8.5	11.0	7.0	1832	6652	2301	3748
N = 15,487	Two or More	53.8	52.6	49.4	50.5	132	430	176	216
Person Behind Driver	Yes	59.3	64.2	33.3	50.0	27	67	27	32
N = 15,478	No	13.6	10.7	13.5	9.1	1937	7010	2448	3930
Manufacturer	GM	14.0	10.6	14.3	9.4	857	4177	1257	2301
N = 15,487	Ford	14.5	11.5	13.6	9.5	823	1927	685	1026
	Other	14.4	13.0	12.3	9.3	284	978	535	637
Driver Sex	Male	13.2	10.4	12.7	8.6	1360	4459	1635	2372
N = 15,367	Female	17.3	12.7	15.9	10.6	573	2579	816	1573

The choice of cutting points used to categorize a variable was not completely arbitrary. Whenever appropriate (and possible), several different "versions" of a given variable--each with different cutting points, and in many cases, with a different number of categories--were input into the variable selection procedure. Only one "version" of a variable, that with the highest harmonic mean of LRχ^2's, was used in subsequent analyses. Figure 3-1 illustrates a typical example of the effort involved in determining the "optimal" cutting points of the variable City Size in the Texas 1974 sample. (The 50,000 and 250,000 cutting points are chosen.)

The variables given in Tables 3-5, 3-6 and 3-7 are ranked in descending order according to the strength of their interaction terms with Driver Injury, Pre/Post Standard and Vehicle Body Style. A number of patterns are evident such as frequently higher injury rates with high values of TAD, reduced lighting, female drivers, lighter cars, and accidents in which the seat behind the driver is occupied.

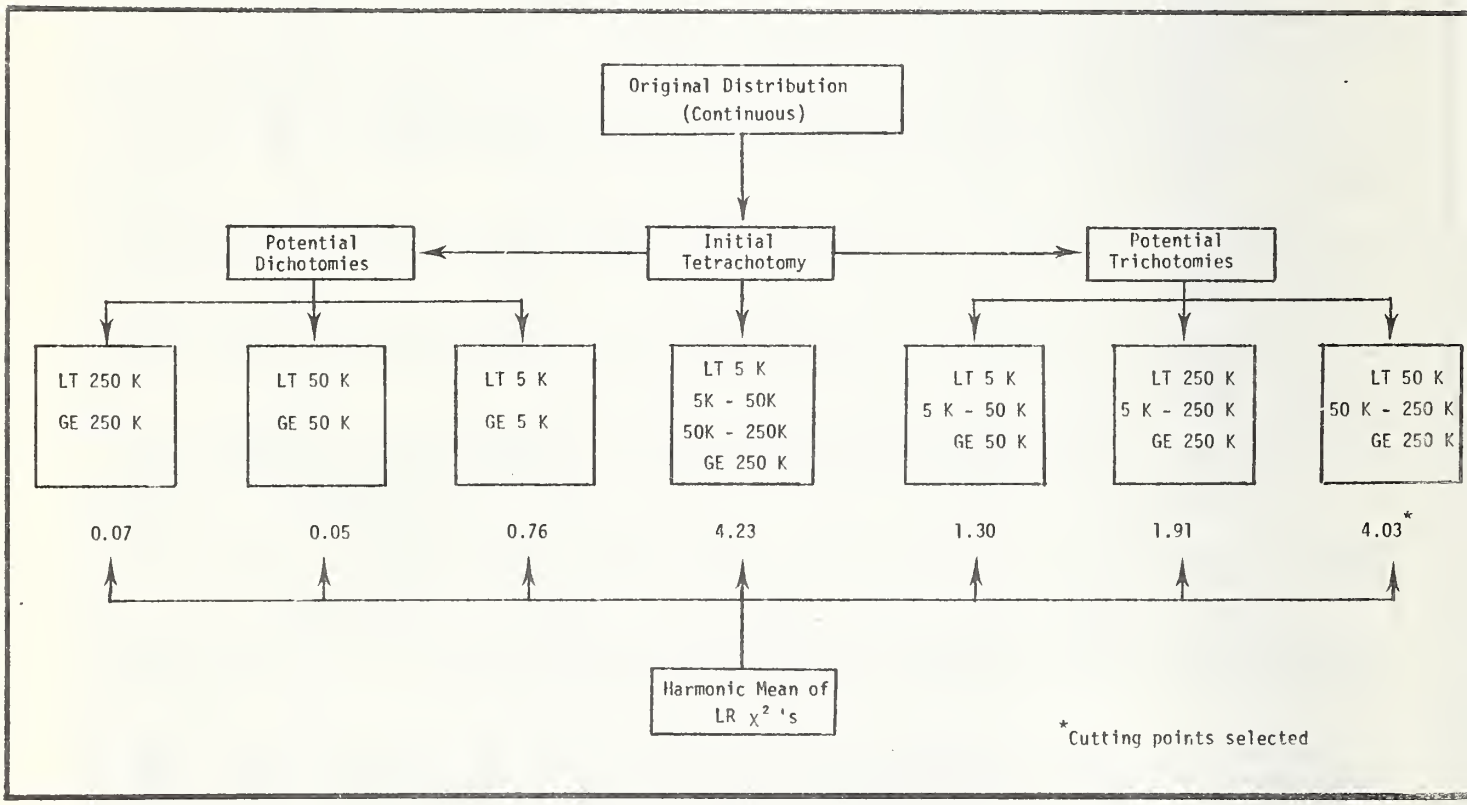

Figure 3-1. Example of determination of "optimal" cutting points of categorical variables.

The information used in the variable selection procedure to determine those variables selected for modeling in the Texas 1972, 1973 and 1974 data is given in Tables 3-8, 3-9 and 3-10. The interaction terms considered here and in all subsequent samples are the following:

- Variable x Style.
- Variable x Prepost.
- Variable x Prepost x Style.
- Variable x Injury.
- Variable x Injury x Prepost.
- Variable x Injury x Style.
- Variable x Injury x Style x Prepost.

The first three interaction terms are obtained from a saturated log-linear model of Prepost, Style and Variable while the last four interaction terms come from a saturated model containing Injury, Prepost, Style and Variable.

The variables are listed in an order determined by the nagnitude of the harmonic mean (also given in the tables) of the seven interaction terms. The use of the harmonic mean results in greater weight being given to the third and fourth order interaction terms than would be the case if the arithmetic mean was used.

Using the harmonic mean as the ordering criteria, City Size was among the three selected variables in the 1972, 1973 and 1974 data bases. Driver Age and Accident Type were selected in two of the three years. Road Classification and TAD were selected in a single year. For completeness and the convenience of the reader, the completely cross-classified tables of Injury, Prepost, Style and the three selected variables that were obtained for the full Texas Drivers-Only data sample for 1972, 1973 and 1974 prior to modeling are given in Appendix A.

TABLE 3-8

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

TEXAS 1972

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Accident Type $\not$	22.96*	154.75*	8.13*	437.19*	1.39	6.83*	1.85	4.43
Driver Age $\not$	1192.01*	96.01*	95.06*	1.93	5.24	3.38	1.76	4.39
City Size $\not$	52.62*	12.86*	5.42	177.44*	13.07*	1.33	1.30	3.72
Vehicle Weight $\not$	1401.37*	489.94*	184.22*	30.79*	5.95	10.71*	0.59	3.51
TAD $\not$	14.92*	10.20*	10.09*	2970.28*	2.46	1.21	1.82	3.42
Light Condition	27.13*	34.53*	1.38	185.32*	2.09	0.49	2.57	1.89
Driver Sex	10.97*	74.61*	1.83	26.76*	1.73	0.60	0.50	1.42
Road Surface Condition	2.26	2.81	2.38	15.94*	1.64	0.57	0.75	1.41
Number of Vehicles	1.06	128.75*	7.01*	355.58*	2.30	0.73	0.27	1.06
Manufacturer $\not$	81.89*	67.58*	32.93*	16.94*	4.91	0.15	3.09	0.96
Road Classification	0.67	40.22*	0.81	67.46*	2.36	0.25	1.05	0.86
Number of Occupants	0.13	37.17*	0.18	1308.79*	4.65	0.07	2.09	0.25
Weather	2.62	6.50*	1.15	8.90*	1.22	0.15	0.02	0.12
Person Behind Driver	0.07	6.71*	1.46	293.28*	0.02	0.16	0.02	0.06

*$p < 0.05$

$\not$ Interaction terms associated with variables marked with "$\not$" have two degrees of freedom. Interaction terms associated with the unmarked variables have one degree of freedom.

Note: Variables above the bold line were selected.

TABLE 3-9

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

TEXAS 1973

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
City Size /	77.06*	8.90*	11.51*	31.41*	3.21	1.69	4.29	5.07
Road Classification /	9.85*	48.20*	2.53	47.20*	3.34	13.80*	1.68	4.67
Driver Age /	1101.75*	75.68*	78.32*	1.42	4.13	8.38*	2.19	4.52
Vehicle Weight /	820.47*	614.80*	96.75*	40.33*	0.59	1.22	6.69*	2.59
Manufacturer /	99.48*	70.01*	39.98*	11.51*	3.03	0.78	0.79	2.32
Accident Type /	14.18*	125.71*	3.13	479.00*	0.27	4.64	1.97	1.45
Number of Occupants	1.09	21.77*	1.27	1050.30*	6.85*	0.73	0.30	1.06
Person Behind Driver	7.71*	3.06	6.00*	197.01*	0.18	4.43*	0.70	0.89
TAD /	13.41*	0.12	0.18	2792.82*	1.81	3.70	1.08	0.45
Light Condition	15.07*	18.27*	5.37*	265.24*	0.10	0.07	0.82	0.27
Weather	1.06	4.12*	4.82*	3.96*	0.22	0.02	0.51	0.12
Road Surface Condition	1.49	4.25*	7.99*	8.65*	1.58	0.45	0.01	0.07
Number of Vehicles	0.32	104.54*	2.08	417.07*	0.12	0.01	0.01	0.03
Driver Sex	0.26	91.50*	1.05	11.62*	0.14	2.30	0.01	0.001

*$p < 0.05$

/Interaction terms associated with variables marked with "/" have two degrees of freedom. Interaction terms associated with the unmarked variables have one degree of freedom.

Note: Variables above the bold line were selected.

TABLE 3-10

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

TEXAS 1974

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
City Size $\not$	86.85*	6.04*	1.23	22.43*	4.63	4.02	4.21	4.03
Accident Type $\not$	7.12*	103.48*	14.40*	494.26*	5.63	4.95	0.75	3.62
TAD $\not$	9.38*	4.21	0.85	2490.96*	4.27	1.18	3.04	2.39
Vehicle Weight $\not$	751.27*	722.17*	86.26*	32.26*	3.06	2.56	0.43	2.27
Driver Age $\not$	991.31*	55.68*	48.63*	1.45	2.44	5.02	0.45	1.97
Road Classification $\not$	1.89	28.32*	0.97	25.50*	0.85	1.63	2.70	1.84
Light Condition	34.01*	8.72*	6.48*	201.65*	0.42	1.17	1.18	1.60
Number of Vehicles	0.73	103.23*	11.58*	422.62*	5.60*	0.44	0.93	1.40
Road Surface Condition	0.83	2.95	0.17	16.69*	2.91	0.29	1.04	0.57
Weather	0.48	4.09*	0.34	10.18*	2.44	0.76	0.16	0.52
Number of Occupants	0.11	6.33*	1.41	1029.41*	6.72*	0.06	0.66	0.25
Person Behind Driver	0.59	3.16	0.04	172.26*	6.38*	5.16*	0.82	0.24
Manufacturer $\not$	62.11*	155.85*	50.46*	2.22	2.45	3.15	0.02	0.14
Driver Sex	7.92*	51.53*	0.18	17.91*	0.34	0.02	0.06	0.09

*$p < 0.05$

$\not$Interaction terms associated with variables marked with "$\not$" have two degrees of freedom. Interaction terms associated with the unmarked variables have one degree of freedom.

Note: Variables above the bold line were selected.

New York 1974

The size of the seat back lock drivers-only data set relative to the entire 1974 New York accident data base is characterized by noting the fraction of accidents, vehicles and fatalities contained in the data set as given in Table 3-11. The reasons for the low fatality rate are basically the same as those given in the discussion of the Texas partial data set (page 3-5).

TABLE 3-11

ACCIDENTS, VEHICLES AND FATALITIES IN 1974
NEW YORK STATE DATA BASE

Variable	Full Data Base	Partial Data Set	Percent
Accidents	377,818	52,475	13.9
Vehicles	704,477	65,593	9.3
Fatalities	2,664	208	7.8

The partial data set was derived by selecting cases that satisfied the following criteria:

- Number of Vehicles in Accident = 1 or 2.
- First Event = Collision with Motor Vehicle or Fixed Object.
- Area of Impact = Frontal, front right fender or front left fender.
- Vehicle Body Type = 2-door or 4-door Sedan.
- Vehicle Model Year is known.
- Vehicle Make and Model = "Domestic."
- Vehicle Occupant = Driver.

The univariate frequencies of some key variables in the New York drivers-only sample are given in Table 3-12. It is noted that almost 6 percent of the drivers suffered a fatal or serious injury (KA), a much higher percent than in Texas or North Carolina. The much higher incidence of serious injury is related to the fact that KABCO in New York was derived from more accurate information describing type of injury, location of injury and drivers' physical and emotional status. Perhaps the principal reason that injury rates are higher in New York is that the dollar damage reporting threshold is higher. The New York sample is tilted toward 2-door, Post-Standard cars. There are twice as many 2-door cars as 4-door cars and four times as many Post-Standard as Pre-Standard vehicles. The preference for 2-door cars is higher in New York than in Texas or North Carolina. The frequencies of associated inclement weather and surface road conditions other than dry are also higher in New York compared with the other two states analyzed.

TABLE 3-12

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY NEW YORK 1974 SAMPLE

Variable	Category	Absolute Frequency	% of Known
Driver Injury	K	208	0.3
	A	3,568	5.5
	B	8,383	12.8
	C	7,714	11.8
	O	45,413	69.6
	Injured Extent - Unknown	307	-
Model Year Class	Pre	12,996	19.8
	Post	52,597	80.2
Vehicle Body Style	2-Door	43,767	66.7
	4-Door	21,826	33.3
Road Classification	State or Interstate Hwy	21,929	34.7
	County or Town Road	15,208	24.0
	City Street	22,595	35.7
	Limited Access	3,542	5.6
	Missing	2,319	-
Weather	Clear	37,227	57.0
	Cloudy	12,721	19.5
	Rain	10,272	15.7
	Snow	3,746	5.7
	Sleet/Hail/Freezing Rain	871	1.3
	Fog/Smog/Smoke	439	0.7
	Other	66	0.1
	Missing	251	-
Road Surface Condition	Dry	41,746	64.2
	Wet	16,066	24.6
	Muddy	95	0.1
	Snow-Ice	6,229	9.5
	Slush	817	1.3
	Other	166	0.3
	Missing	274	-
Vehicle Damage	None	765	1.2
	Light	19,049	29.5
	Moderate	34,280	53.1
	Severe	9,893	15.3
	Demolished	560	0.9
	Missing	1,046	-
Driver Age	15-24	23,039	35.2
	25-34	14,964	22.9
	35-49	12,991	19.8
	50+	14,453	22.1
	Missing	146	-

TABLE 3-12 (Continued)

Variable	Category	Absolute Frequency	% of Known
Driver Sex	Male	45,196	68.9
	Female	20,397	31.1
Number of Occupants	One	36,742	60.6
	Two or More	23,882	39.4
	Missing	4,969	-
Restraint Usage	None Used	34,341	72.1
	Lap Belt	11,243	23.6
	Harness	533	1.1
	Lap Belt and Harness	1,372	2.9
	Child Restraint	3	0.0
	Other	113	0.2
	Missing	17,988	-
Vehicle Weight	LT 3000 lbs	15,386	24.0
	3000-3599 lbs	21,321	33.3
	3600-4399 lbs	22,684	35.3
	GE 4000 lbs	4,797	7.5
	Missing	1,405	-
Number of Vehicles	One	9,949	15.2
	Two or More	55,644	84.8
Manufacturer	GM	33,414	50.9
	Ford	15,988	24.4
	Other	16,191	24.7
Total Number of Cases		65,593	-

TABLE 3-13

INJURY RATES FOR NEW YORK 1974

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Road Classification N = 63,274	State or Interstate Highway	38.3	31.8	35.8	28.8	2,608	14,508	2,096	6,259
	County or Town Road	40.8	33.5	38.8	30.3	1,884	8,823	1,310	3,191
	City Street	31.3	29.2	30.7	24.4	2,498	11,868	2,232	5,997
Driver Age N = 65,447	15-24	37.0	32.1	37.8	28.3	3,256	14,008	2,087	3,688
	25-49	35.9	31.0	33.2	27.4	2,730	15,751	2,449	7,025
	50 or Older	33.6	28.0	30.6	25.5	1,189	6,727	1,240	5,297
Manufacturer N = 65,593	GM	35.4	29.3	33.6	25.7	3,547	19,115	2,758	7,994
	Ford	36.7	31.7	36.8	27.6	2,262	8,969	1,202	3,555
	Other	36.3	33.4	33.5	28.8	1,399	8,475	1,828	4,489
Number of Occupants N = 60,624	One	39.2	33.8	39.3	29.8	3,830	20,995	3,014	8,903
	Two or More	33.5	27.8	29.2	24.0	2,801	12,843	2,312	5,926
Road Surface Condition N = 65,319	Dry	36.8	31.4	33.9	27.6	4,640	23,505	3,579	10,222
	Other	34.8	30.0	35.1	26.1	2,542	12,914	2,178	5,739
Point of Impact N = 65,593	Hood & Front	42.4	37.6	41.5	33.5	4,062	19,591	3,118	8,253
	Right Front	28.9	23.2	26.2	20.8	1,738	9,116	1,541	4,224
	Left Front	26.3	22.8	25.1	19.2	1,408	7,852	1,129	3,561
Towaway N = 65,593	No	21.7	17.5	20.1	15.4	4,198	21,884	3,508	10,447
	Yes	55.8	50.7	55.1	48.6	3,010	14,675	2,280	5,591
Vehicle Weight N = 64,188	LT 3,000 lbs	39.1	36.0	39.6	34.1	2,502	10,176	1,199	1,509
	3,000 lbs or More	34.3	28.8	33.3	26.4	4,705	26,205	4,347	12,545
Restraint Usage N = 47,605	No	46.0	40.5	44.5	36.3	4,599	18,179	3,701	7,978
	Yes	35.4	34.1	35.6	31.0	810	8,508	579	3,251
Number of Vehicles N = 65,593	One	76.4	65.0	77.1	64.1	1,273	5,715	985	1,976
	Two	27.3	24.5	25.4	21.8	5,935	30,844	4,803	14,062
Driver Sex N = 65,593	Male	34.2	28.6	31.7	24.8	5,293	24,627	4,142	11,134
	Female	40.8	35.6	40.6	31.9	1,915	11,932	1,646	4,904
Vehicle Damage N = 64,547	None-Light	20.9	17.5	19.7	15.3	2,050	10,732	1,756	5,276
	Moderate	35.4	30.2	34.2	27.5	3,757	19,211	2,999	8,313
	Severe-Demolished	63.3	57.4	63.6	55.6	1,285	6,070	929	2,169
Weather N = 65,342	Clear-Cloudy	36.5	30.9	34.0	27.3	5,526	27,858	4,371	12,193
	Other	34.9	31.0	35.3	26.2	1,658	8,562	1,390	3,784

TABLE 3-14

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

NEW YORK 1974

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Road Classification	196.33*	59.74*	2.67	151.73*	8.65*	2.34	3.90	5.823
Driver Age	1818.67*	466.75*	118.89*	63.90*	1.55	1.19	4.09	3.985
Manufacturer	356.84*	66.30*	115.20*	57.76*	9.65*	0.85	1.00	3.013
Number of Occupants	18.39*	61.04*	0.75	266.10*	0.89	2.43	4.08*	2.196
Road Surface Condition	5.36*	2.44	3.99*	11.46*	0.86	0.53	2.95	1.620
Point of Impact	30.58*	38.74*	1.87	1631.16*	0.76	0.46	1.99	1.527
Towaway	130.03*	34.44*	9.64*	8100.39*	2.78	2.44	0.13	0.814
Vehicle Weight	2324.08*	431.34*	136.67*	243.04*	5.62*	0.87	0.07	0.448
Restraint Usage	35.91*	1125.01*	0.11	170.02*	5.80*	0.80	0.05	0.230
Number of Vehicles	83.48*	76.82*	18.07*	6739.11*	47.94*	5.26*	0.01	0.070
Driver Sex	9.43*	96.48*	18.08*	334.49*	0.01	1.57	0.67	0.069
Vehicle Damage	119.75*	28.74*	5.85	5141.41*	0.16	2.21	0.01	0.066
Weather	1.06	0.04	1.04	0.57	0.01	0.11	3.36	0.051

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: road classification, driver age, manufacturer, point of impact and vehicle damage. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

Injury rates (KABC percentages) and the number of drivers on which the rates are based are given in Table 3-13. High injury rates occur for towaway accidents, direct frontal impacts, lighter-weight vehicles, severely damaged vehicles, lack of restraint usage, female drivers and drivers age 15-24 years old. The last variable result requires comment since it appears to differ from the results for Texas and North Carolina. In Texas, Driver Age is a dichotomy and drivers 35 years and older have higher injury rates. The categories of Driver Age differ in North Carolina among years but in no case does the category 15-25 years old have the highest rates. Environmental and socioeconomic factors that differ among the three states could be important in explaining this difference. Also, it should be noted that the overall injury rate is much higher in New York (31%) compared to Texas (11%) and North Carolina (15%).

The information used in the variable selection procedure to determine those variables selected for modeling of the New York 1974 data is given in Table 3-14. Ordering the variables according to the harmonic mean of the seven interaction terms resulted in Road Classification, Driver Age and Manufacturer being the leading three variables that were selected for modeling of the New York 1974 data sample. The completely cross-classified tables of the New York Driver-Only 1974 data prior to modeling are given for Injury, Prepost, Style, Road Classification, Driver Age and Manufacturer in Appendix A. A separate table is given for each of the three injury dichotomies--KA vs BCO, KAB vs CO and KABC vs O.

North Carolina 1973, 1974, 1975

The size of the seat back lock drivers-only data set relative to the entire 1973-1975 North Carolina accident data base can be characterized by noting the fraction of accidents, vehicles and fatalities contained in the data set as given in Table 3-15. The reasons for the low fatality rate have been discussed previously (page 3-5).

TABLE 3-15

ACCIDENTS, VEHICLES AND FATALITIES IN 1973-1975
North Carolina Data Base

Year	Variable	Full Data Base	Partial Data Set	Percent
1973	Accidents	129,150	21,876	16.9
	Vehicles	232,825	27,345	11.7
	Fatalities	1,859	54	2.9
1974	Accidents	121,568	21,366	17.6
	Vehicles	218,506	26,707	12.2
	Fatalities	1,585	47	3.0
1975	Accidents	129,013	22,729	17.6
	Vehicles	232,180	28,411	12.2
	Fatalities	1,519	56	3.7

The basic data set was derived by selecting all drivers in passenger vehicles that satisfied the following criteria:

- Involved in two-car head-on collision.
- Involved in two-car collision other than head-on, and sustained front end damage.
- Involved in single-car collision with a fixed object and sustained front end damage.
- Collided with a parked car and sustained front end damage.

Thus, the data subset includes all passenger cars involved in frontal impact accidents that could indicate the effects of seat back locks. Vehicles involved in multi-vehicle accidents are excluded from the sample as are all struck vehicles. Vehicles striking non-fixed objects such as animals, bicyclists and pedestrians are similarly excluded.

The data base was screened using the following variables and conditions:

- Means of Involvement in Accident = More than 2 Vehicles Involved.
- Vehicle Type = 2-door or 4-door Sedan.
- Vehicle Body Style = 2-door Sedan or 2-door Hardtop, or 4-door Sedan or 4-door Hardtop.
- Vehicle Model Year = 1960 or later.
- Vehicle Make = Domestic.
- Region of Impact = Frontal Collision.
- Accident Type = Hit Parked Vehicle, Hit Fixed Object Head-On, Other 2-Vehicle.

The univariate frequencies of some key variables in the North Carolina drivers-only sample are given in Table 3-16. Unique features of the North Carolina sample include a high frequency of known information on Alcohol Involvement (97%) and Restraint Usage (93%). Other unique information in the North Carolina sample includes Estimated Vehicle Speed and Adjusted Vehicle Speed. Estimated Vehicle Speed refers to the speed of the vehicle prior to impact. This speed is adjusted in two-vehicle collisions to account for the speed of the other vehicle to obtain Adjusted Vehicle Speed. Note that TAD is not included in the table, as 54 percent of the data are missing.

Injury Rates (KABC percentages) and the number of drivers on which the rates are based are given in Tables 3-17, 3-18 and 3-19 for the North Carolina 1973, 1974 and 1975 drivers-only sample. Higher injury rates occur for lower vehicle weights, higher estimated and adjusted vehicle speeds, state and interstate highways, alcohol involvement, failure to use restraints, reduced light conditions and presence of an occupant seated behind the driver.

TABLE 3-16

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY NORTH CAROLINA SAMPLE

Variable	Category	1973		1974		1975		Total: 1973-1975	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
KABCO	K	54	0.2	47	0.2	56	0.2	157	0.2
	A	626	2.3	564	2.1	550	1.9	1,740	2.1
	B	1,674	6.1	1,654	6.2	1,799	6.3	5,127	6.2
	C	1,713	6.3	1,791	6.7	2,029	7.1	5,533	6.7
	O	23,278	85.1	22,651	84.8	23,977	84.4	69,906	84.8
Model Year Class	Pre	8,936	32.7	7,331	27.4	6,708	23.6	22,975	27.9
	Post	18,409	67.3	19,376	72.6	21,703	76.4	59,488	72.1
Vehicle Body Style	2-Door	15,522	56.8	14,990	56.1	15,787	55.6	46,299	56.1
	4-Door	11,823	43.2	11,717	43.9	12,624	44.4	36,164	43.9
City Size	Rural	10,877	39.8	9,743	36.5	9,919	34.9	20,183	24.5
	Under 1,000	309	1.1	324	1.2	382	1.3	4,675	5.7
	1,000- 4,999	1,688	6.2	1,689	6.3	1,838	6.5	4,005	4.9
	5,000- 9,999	1,448	5.3	1,424	5.3	1,600	5.6	3,496	4.2
	10,000-14,999	1,101	4.0	1,125	4.2	1,268	4.5	2,068	2.5
	15,000-19,999	1,030	3.8	1,067	4.0	1,204	4.2	3,301	4.0
	20,000-24,999	633	2.3	665	2.5	770	2.7	3,494	4.2
	25,000-34,999	1,058	3.9	1,144	4.3	1,294	4.6	4,472	5.4
	35,000-49,999	1,407	5.1	1,333	5.0	1,265	4.5	5,215	6.3
	50,000-75,000	1,434	5.2	1,523	5.7	1,718	6.0	1,015	1.2
	GT 75,000	6,360	23.3	6,670	25.0	7,153	25.2	30,539	37.0
Road Classification	Interstate	403	1.5	255	1.0	294	1.0	952	1.2
	U.S.	4,801	17.6	4,302	16.1	4,325	15.3	13,428	16.3
	North Carolina	2,985	11.0	2,670	10.0	2,840	10.0	8,495	10.3
	Rural Paved Rd	3,987	14.6	3,695	13.9	3,850	13.6	11,532	14.0
	Rural Unpaved Rd	382	1.4	420	1.6	350	1.2	1,152	1.4
	City Street	14,661	53.9	15,300	57.4	16,678	58.9	46,639	56.7
	Missing	126	-	65	-	74	-	265	-
Weather	Clear	18,104	66.6	17,416	65.6	18,264	64.6	53,784	65.6
	Cloudy	4,816	17.7	4,792	18.0	4,992	17.7	14,600	17.8
	Rain	3,581	13.2	3,927	14.8	4,548	16.1	12,056	14.7
	Snowing	359	1.3	101	0.4	165	0.6	625	0.8
	Fog	286	1.1	270	1.0	242	0.9	798	1.0
	Sleet or Hail	44	0.2	46	0.2	41	0.1	131	0.2
	Missing	155	-	155	-	159	-	469	-
Accident Type	Coll.w Fixed Obj	1,558	5.7	1,432	5.4	1,374	4.8	4,363	5.3
	Coll.w Motor Veh	25,787	94.3	25,275	94.6	27,037	95.2	78,099	94.7
Light Condition	Daylight	20,582	75.4	19,951	74.9	21,489	75.8	62,022	75.4
	Dusk	893	3.3	863	3.2	947	3.3	2,703	3.3
	Dawn	276	1.0	270	1.0	281	1.0	827	1.0
	Dark/Lit	3,078	11.3	3,307	12.4	3,365	11.9	9,750	11.8
	Dark/Unlit	2,484	9.1	2,261	8.5	2,253	8.0	6,998	8.5
	Missing	32	-	55	-	76	-	163	-
Road Surface Condition	Dry	21,264	77.9	20,864	78.3	21,848	77.1	63,976	77.8
	Wet	4,981	18.2	5,571	20.9	6,200	21.9	16,752	20.4
	Oily	26	0.1	20	0.1	11	0.0	57	0.1
	Muddy	43	0.2	24	0.1	30	0.1	97	0.1
	Snowy	380	1.4	74	0.3	111	0.4	565	0.7
	Icy	611	2.2	100	0.4	122	0.4	833	1.0
	Missing	40	-	54	-	89	-	183	-
Investigating Agency	City Police	16,267	59.5	16,740	62.7	18,198	64.1	51,205	62.1
	Sheriff	7	0.0	11	0.0	16	0.1	34	0.0
	Rural Cnty Police	145	0.5	76	0.3	53	0.2	274	0.3
	Highway Patrol	10,919	39.9	9,869	37.0	10,126	35.6	30,914	37.5
	Other	7	0.0	11	0.0	18	0.1	36	0.0

TABLE 3-16

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY NORTH CAROLINA SAMPLE (Continued)

Variable	Category	1973		1974		1975		Total: 1973-1975	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
Estimated Vehicle Speed	1-29 mph	13,834	53.1	13,863	54.1	14,765	53.9	42,462	53.7
	30-49 mph	9,313	35.8	9,287	36.2	10,118	36.9	28,718	36.3
	50+ mph	2,884	11.1	2,474	9.7	2,521	9.2	7,879	10.0
	Missing	1,314	-	1,083	-	1,007	-	3,404	-
Adjusted Vehicle Speed	1-29 mph	10,802	42.6	10,920	43.2	11,938	44.0	33,660	43.3
	30-49 mph	11,098	43.7	11,443	45.3	12,305	45.3	34,846	44.8
	50+ mph	3,474	13.7	2,891	11.4	2,882	10.6	9,248	11.9
	Missing	1,971	-	1,453	-	1,285	-	4,709	-
Driver Age	15-25	11,606	42.8	11,228	42.3	11,800	41.7	34,634	42.3
	26-55	11,846	43.7	11,466	43.2	12,294	43.4	35,606	43.4
	56+	3,671	13.5	3,826	14.4	4,211	14.9	11,708	14.3
	Missing	222	-	187	-	106	-	515	-
Driver Sex	Male	17,464	64.0	16,883	63.4	17,643	62.1	51,990	63.2
	Female	9,808	36.0	9,752	36.6	10,751	37.9	30,311	36.8
	Missing	73	-	72	-	17	-	162	-
Alcohol Involvement	No	24,838	93.5	23,926	92.4	25,601	93.1	74,365	93.0
	Drnkng-Impaired	812	3.1	1,046	4.0	1,042	3.8	2,900	3.6
	Drnkng-Imp Unk	910	3.4	915	3.5	865	3.1	2,690	3.4
	Missing	785	-	820	-	903	-	2,508	-
Restraint Usage	No Belt	21,053	85.6	21,729	85.5	23,505	87.0	66,287	86.1
	Lap Belt	3,331	13.5	3,044	12.0	2,853	10.6	9,228	12.0
	Lap & Shoulder	121	0.5	506	2.0	623	2.3	1,250	1.6
	Shoulder Only	104	0.4	129	0.5	26	0.1	259	0.3
	Missing	2,736	-	1,299	-	1,404	-	5,439	-
Number of Occupants	One	16,964	63.4	16,526	61.9	17,318	61.0	50,808	62.1
	Two or More	9,804	36.6	10,175	38.1	11,087	39.0	31,066	37.9
	Missing	577	-	6	-	6	-	589	-
Person Behind Driver	Yes	2,065	7.6	2,043	7.6	2,377	8.4	6,485	7.9
	No	25,280	92.4	24,664	92.4	26,034	91.6	75,978	92.1
Vehicle Weight	LT 3,000 lbs	5,601	20.6	5,182	19.5	5,420	19.2	16,203	19.8
	3,000-3,599 lbs	11,544	42.4	10,351	39.0	10,473	37.1	32,368	39.5
	GT 3,600 lbs	10,065	37.0	11,006	41.5	12,343	43.7	33,414	40.8
	Missing	135	-	168	-	175	-	478	-
Number of Vehicles	One	198	0.7	208	0.8	227	0.8	633	0.8
	Two	27,147	99.3	26,499	99.2	28,184	99.2	81,830	99.2
Manufacturer	GM	14,335	52.4	14,311	53.6	15,148	53.3	43,794	53.1
	Ford	8,654	31.6	8,160	30.6	8,795	31.0	25,609	31.1
	Other	4,356	15.9	4,236	15.9	4,468	15.7	13,060	15.8
Model Year Category	Early Pre-Stnd	4,689	17.1	3,584	13.4	3,130	11.0	11,403	13.8
	Late Pre-Stnd	4,247	15.5	3,747	14.0	3,578	12.6	11,572	14.0
	Early Post-Stnd	16,102	58.9	14,727	55.1	14,999	52.8	45,828	55.6
	Late Post-Stnd	2,307	8.4	4,646	17.4	6,704	23.6	13,660	16.6
Total Number of Cases		27,345	-	26,707	-	28,411	-	82,463	-

TABLE 3-17

INJURY RATES FOR NORTH CAROLINA 1973

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Vehicle Weight	LT 3,000 lbs	18.3	17.3	19.3	18.7	1,543	2,736	739	583
N = 27,210	3,000-3,599 lbs	17.0	14.5	15.4	14.3	2,476	5,031	2,034	2,003
	3,600+ lbs	12.8	12.7	15.4	12.0	695	3,021	1,388	4,961
Manufacturer	GM	16.9	13.8	15.5	12.3	1,943	5,682	2,168	4,542
N = 27,345	Ford	17.0	15.9	16.7	13.3	2,326	3,165	1,458	1,705
	Other	16.0	15.4	17.1	15.8	462	1,944	579	1,371
Adjusted Vehicle Speed	1-29 MPH	8.1	7.3	9.0	7.2	1,770	4,274	1,661	3,097
N = 25,373	30-49 MPH	21.3	17.7	19.1	16.4	2,000	4,317	1,757	3,024
	50+ MPH	25.9	27.9	31.4	23.4	603	1,424	481	966
Driver Age	15-25	15.8	14.5	14.5	11.8	2,629	5,837	1,455	1,685
N = 27,123	26-55	18.3	15.3	17.7	13.6	1,712	4,239	1,731	4,164
	56+	17.7	13.5	16.1	13.7	351	615	983	1,722
Estimated Vehicle Speed	1-29 MPH	9.6	8.5	11.1	8.1	2,275	5,215	2,269	4,075
N= 26,031	30-49 MPH	22.2	18.2	20.9	18.1	1,731	3,788	1,400	2,394
	50+ MPH	28.5	29.9	32.5	25.2	513	1,262	323	786
City Size	LT 50,000	17.1	15.9	16.9	13.9	3,500	7,473	3,126	5,452
N = 27,345	50,000+	16.3	13.0	13.9	11.6	1,231	3,318	1,079	2,166
Road Classification	State or Interstate Highway	19.3	17.9	19.1	16.3	1,335	3,350	1,173	2,331
N = 27,219	Rural Road	18.0	14.4	17.7	14.0	942	1,713	673	1,041
	City Street	15.1	12.9	14.0	11.2	2,435	5,682	2,333	4,212
Accident Type	Coll.wFixed Obj	21.1	21.3	20.1	16.6	350	558	259	391
N = 27,345	Coll.wMotor Veh	16.5	14.4	15.9	13.0	4,381	10,233	3,946	7,227
Restraint Usage	Yes	13.9	12.5	12.4	12.2	267	1,604	291	1,394
N = 24,609	No	17.7	15.8	17.1	14.3	3,984	8,152	3,489	5,428
Light Condition	Daylight	15.5	13.0	15.2	12.1	3,443	7,948	3,207	5,984
N = 27,313	Reduced Light	20.6	19.6	19.3	17.0	1,284	2,832	995	1,620

TABLE 3-17

INJURY RATES FOR NORTH CAROLINA 1973 (Continued)

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Road Surface Condition N = 27,305	Dry	16.9	15.1	16.4	13.6	3,669	8,309	3,310	5,976
	Other	16.7	13.4	15.0	11.7	1,056	2,467	891	1,627
Investigating Agency N = 27,186	City Police	15.2	13.1	14.4	11.4	2,677	6,376	2,549	4,665
	Highway Patrol	18.9	17.2	18.8	16.0	2,037	4,339	1,635	2,908
Weather N = 27,190	Clear-Cloudy	16.8	14.8	15.9	13.1	3,985	8,946	3,556	6,433
	Other	17.7	14.8	17.8	13.5	713	1,796	619	1,142
Person Behind Driver N = 27,345	No	16.6	14.6	15.8	13.1	4,356	9,991	3,896	7,037
	Yes	19.7	16.4	20.4	13.6	375	800	309	581
Driver Sex N = 27,272	Male	15.6	12.8	13.0	10.9	3,282	6,892	2,651	4,639
	Female	22.1	18.2	21.6	16.8	1,436	3,869	1,540	2,963
Number of Vehicles N = 27,345	One	37.8	34.9	33.3	34.9	45	86	24	43
	Two	16.6	14.6	16.0	13.0	4,686	10,705	4,181	7,575
Alcohol Involvement N = 26,560	No	15.4	13.8	15.2	12.7	4,158	9,849	3,758	7,073
	Yes	27.3	24.7	22.9	19.1	388	648	336	350
Number of Occupants N = 26,768	One	15.9	14.0	15.2	12.6	2,800	6,678	2,618	4,868
	Two or More	18.6	16.2	18.0	14.5	1,824	3,884	1,493	2,603

TABLE 3-18

INJURY RATES FOR NORTH CAROLINA 1974

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Vehicle Weight N = 26,539	LT 3,000 lbs	17.6	19.7	21.4	18.3	1,224	2,744	641	573
	3,000-3,599 lbs	16.8	15.1	17.3	14.3	1,886	4,768	1,754	1,943
	3,600+ lbs	16.9	13.2	13.9	12.0	592	3,724	1,176	5,514
Manufacturer N = 26,707	GM	16.2	14.4	17.3	12.4	1,492	6,105	1,968	4,746
	Ford	17.4	16.4	17.1	13.6	1,871	3,236	1,138	1,915
	Other	18.5	17.9	15.4	14.4	363	1,923	499	1,451
Adjusted Vehicle Speed N = 25,254	1-29 MPH	8.3	7.8	9.4	6.9	1,423	4,616	1,508	3,373
	30-49 MPH	19.9	18.2	20.8	15.8	1,692	4,780	1,511	3,460
	50+ MPH	31.2	32.4	33.0	25.9	398	1,269	373	851
Road Classification N = 26,642	State or Interstate Highway	19.0	18.5	20.4	15.5	968	3,082	936	2,241
	Rural Road	20.0	17.0	18.5	15.8	712	1,749	547	1,107
	City Street	15.2	13.8	15.2	11.2	2,039	6,413	2,108	4,740
Driver Age N = 26,520	15-25	15.0	15.1	15.9	12.1	2,016	5,988	1,270	1,954
	26+	19.5	16.0	17.6	13.4	1,686	5,194	2,309	6,103
Light Condition N = 26,652	Daylight	15.9	14.1	14.9	12.1	2,703	8,272	2,709	6,267
	Reduced Light	20.1	19.5	23.5	16.5	1,011	2,972	892	1,826
Restraint Usage N = 25,408	Yes	11.6	14.3	16.1	10.4	215	1,821	193	1,450
	No	17.6	16.2	17.3	13.8	3,331	8,928	3,216	6,254
Investigating Agency N = 26,609	City Police	14.9	13.7	15.2	11.2	2,229	7,022	2,294	5,195
	Highway Patrol	20.1	18.5	20.2	16.2	1,489	4,194	1,296	2,890
Estimated Vehicle Speed N = 25,624	1-29 MPH	10.3	9.2	11.1	8.2	1,855	5,550	2,007	4,451
	30-49 MPH	21.1	19.8	22.3	17.7	1,367	4,104	1,160	2,656
	50+ MPH	31.7	31.0	38.2	27.5	347	1,160	280	687
Number of Vehicles N = 26,707	One	32.0	35.1	50.0	27.1	25	111	24	48
	Two	16.9	15.4	16.8	12.9	3,701	11,153	3,581	8,064

TABLE 3-18

INJURY RATES FOR NORTH CAROLINA 1974 (Continued)

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
City Size N = 26,707	LT 5,000 5,000+	19.1 15.2	17.4 14.1	19.3 15.1	15.4 11.3	1,745 1,981	4,936 6,328	1,598 2,007	3,477 4,635
Person Behind Driver N = 26,707	No Yes	16.7 20.5	15.4 18.1	16.9 18.5	12.8 15.6	3,428 298	10,442 822	3,291 314	7,503 609
Road Surface Condition N - 26,653	Dry Other	17.0 17.1	15.6 15.3	17.3 16.0	13.0 13.1	2,918 795	8,763 2,485	2,832 769	6,351 1,740
Alcohol Involvement N = 25,887	No Yes	15.4 26.4	14.5 26.2	15.9 25.6	12.5 19.3	3,204 390	10,181 770	3,127 344	7,414 457
Driver Sex N = 26,635	Male Female	14.8 22.2	13.2 19.7	15.1 20.4	11.2 15.8	2,604 1,110	7,085 4,146	2,337 1,259	4,857 3,237
Number of Occupants N = 26,701	One Two or More	16.6 17.7	15.1 16.3	16.2 18.4	12.5 14.0	2,199 1,525	6,956 4,307	2,240 1,365	5,131 2,978
Accident Type N = 26,707	Coll.w Fixed Obj Coll.w Motor Veh	21.6 16.7	20.4 15.3	22.9 16.6	19.3 12.7	232 3,494	565 10,699	236 3,369	399 7,713
Weather N = 26,552	Clear-Cloudy Other	17.2 16.2	15.4 16.3	17.4 15.2	13.1 12.5	3,072 625	9,361 1,843	3,022 564	6,753 1,312

TABLE 3-19

INJURY RATES FOR NORTH CAROLINA 1975

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Vehicle Weight	LT 3,000 lbs	18.2	19.8	18.8	19.8	1,200	2,908	634	678
N = 28,236	3,000-3,599 lbs	17.8	14.3	16.1	15.7	1,694	4,907	1,619	2,253
	3,600+ lbs	16.8	14.3	15.2	13.5	475	4,539	1,044	6,285
Driver Sex	Male	15.1	12.7	14.6	11.8	2,369	7,640	2,070	5,564
N = 28,394	Female	24.2	20.3	19.5	18.6	1,010	4,756	1,253	3,722
Manufacturer	GM	17.7	14.0	16.0	13.7	1,274	6,743	1,670	5,461
N = 28,411	Ford	17.7	18.1	17.0	16.7	1,726	3,717	1,136	2,216
	Other	18.3	16.2	16.7	14.3	382	1,945	520	1,621
Driver Age	15-25	15.8	15.1	15.5	13.5	1,860	6,403	1,197	2,340
N = 28,305	26-55	20.6	16.3	17.3	15.5	1,200	5,097	1,293	4,704
	56+	18.9	15.5	16.6	13.5	302	864	820	2,225
Estimated Vehicle Speed	1-29 MPH	10.3	9.1	10.4	9.0	1,668	6,180	1,859	5,058
N = 27,404	30-49 MPH	22.4	20.9	23.4	19.7	1,266	4,601	1,139	3,112
	50+ MPH	39.8	29.3	29.3	30.0	334	1,181	213	793
Adjusted Vehicle Speed	1-29 MPH	8.8	8.2	9.0	7.3	1,347	5,190	1,400	4,001
N = 27,126	30-49 MPH	20.6	19.1	20.5	18.0	1,517	5,398	1,448	3,942
	50+ MPH	38.8	30.0	31.1	30.1	384	1,250	305	944
City Size	LT 25,000	18.4	16.7	16.4	15.3	2,167	7,207	2,074	5,533
N = 28,411	25,000+	16.6	14.1	16.5	13.4	1,215	5,198	1,252	3,765
Road Classification	State & Interstate Highway	21.1	18.7	20.3	18.4	904	3,269	824	2,462
N = 28,337	Rural Road	19.3	18.0	16.5	16.1	611	1,851	496	1,242
	City Street	15.7	13.6	14.8	12.5	1,855	7,250	2,001	5,572
Number of Occupants	One	16.5	15.5	16.7	14.3	1,980	7,610	1,949	5,779
N = 28,405	Two or More	19.6	15.8	16.1	14.9	1,401	4,792	1,376	3,518
Number of Vehicles	One	36.4	38.3	64.7	35.5	33	115	17	62
N = 28,411	Two	17.6	15.4	16.2	14.4	3,349	12,290	3,309	9,236

TABLE 3-19

INJURY RATES FOR NORTH CAROLINA 1975 (Continued)

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Weather	Clear-Cloudy	18.2	15.3	16.1	14.2	2,766	10,120	2,751	7,619
N = 28,252	Other	16.0	16.9	18.3	16.1	601	2,217	563	1,615
Investigating Agency	City Police	15.4	13.7	14.8	12.5	2,038	7,949	2,150	6,061
N = 28,324	Highway Patrol	21.5	19.1	19.4	18.4	1,332	4,424	1,167	3,203
Accident Type	Coll.w Fixed Obj	20.5	21.7	24.2	17.2	200	572	194	408
N = 28,411	Coll.w Motor Veh	17.6	15.3	16.0	14.4	3,182	11,833	3,132	8,890
Light Condition	Daylight	16.2	14.5	15.2	13.7	2,463	9,144	2,535	7,347
N = 28,335	Reduced Light	22.0	18.6	20.5	17.8	908	3,233	786	1,919
Alcohol Involvement	No	16.2	14.7	15.5	14.2	2,954	11,165	2,891	8,591
N = 27,508	Yes	30.4	23.6	24.3	19.1	306	830	305	466
Restraint Usage	Yes	11.5	14.4	12.9	13.1	165	1,735	147	1,455
N = 27,007	No	18.4	16.1	17.1	15.0	3,046	10,087	3,012	7,360
Road Surface Condition	Dry	17.9	15.5	16.0	14.2	2,611	9,470	2,594	7,173
N = 28,322	Other	17.4	16.1	18.0	16.8	759	2,900	722	2,093
Person Behind Driver	No	17.6	15.7	16.2	14.5	3,090	11,427	3,006	8,511
N = 28,411	Yes	19.5	14.5	19.1	14.4	292	978	320	787

The information used in the variable selection to determine those variables selected for modeling of the North Carolina 1973-1975 data is given in Tables 3-20, 3-21 and 3-22. Ordering the variables according to the harmonic mean of the seven interaction terms resulted in the selection of variables for each year as follows:

1973	1974	1975
Vehicle Weight	Vehicle Weight	Vehicle Weight
Manufacturer	Manufacturer	Driver Sex
Estimated Vehicle Speed		Manufacturer

The completely cross-classified tables of the North Carolina driver-only 1973-1975 data samples prior to modeling are given in Appendix A.

TABLE 3-20

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE
NORTH CAROLINA 1973

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Vehicle Weight	3217.64*	1428.69*	79.29*	56.59*	1.53	2.30	4.29	5.175
Manufacturer	290.66*	778.38*	26.53*	13.03*	3.19	3.73	1.16	4,480
Estimated Vehicle Speed	88.25*	20.85*	6.97*	926.30*	1.62	1.51	6.40*	4.270
Driver Age	2933.48*	154.76*	126.03*	11.16*	1.95	1.79	1.22	3.508
Adjusted Vehicle Speed	6.66*	14.57*	1.33	943.14*	1.03	2.69	8.40*	2.877
City Size	9.14*	44.00*	2.46	20.85*	0.75	0.51	1.28	1.502
Road Classification	44.68*	55.33*	1.67	100.58*	2.04	1.29	0.24	1.152
Accident Type	2.40	30.86*	3.01	28.27*	0.65	0.80	0.37	1.110
Restraint Usage	48.80*	622.91*	0.25	22.80*	0.54	0.32	0.43	0.616
Light Condition	72.48*	7.88*	2.25	118.05*	2.61	1.23	0.05	0.322
Road Surface Condition	7.35*	0.51	0.11	8.26*	1.32	0.33	0.11	0.290
Investigating Agency	21.34*	8.01*	2.46	90.82*	0.88	0.93	0.03	0.194
Weather	7.43*	4.16*	1.73	0.79	0.70	0.24	0.03	0.171
Person Behind Driver	0.02	0.21	1.32	6.28*	1.57	0.04	0.57	0.085
Driver Sex	49.09*	42.53*	8.00*	197.90*	1.92	1.90	0.01	0.070
Number of Vehicles	7.56*	0.62	0.29	50.23*	0.18	0.01	0.15	0.060
Alcohol Involvement	12.71*	76.34*	5.48*	103.84*	0.01	3.27	0.01	0.035
Number of Occupants	15.35*	11.46*	0.81	24.94*	0.18	0.01	0.01	0.034

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: vehicle weight, manufacturer, estimated vehicle speed, driver age, adjusted vehicle speed and road classification. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

TABLE 3-21

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE
NORTH CAROLINA 1974

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Vehicle Weight	2897.22*	165.92*	72.51*	78.63*	5.66	2.75	3.89	8.487
Manufacturer	252.41*	586.49*	77.65*	15.23*	3.65	2.13	0.83	3.445
Adjusted Vehicle Speed	6.99*	4.79	7.47*	1034.68*	0.71	1.96	0.65	1.775
Road Classification	31.07*	28.78*	3.42	92.43*	0.38	0.59	1.64	1.320
Driver Age	1901.69*	77.36*	75.70*	12.39*	3.58	0.22	2.38	1.308
Light Condition	42.03*	5.96*	1.68	108.22*	0.17	0.94	3.56	0.873
Restraint Usage	7.96*	674.04*	3.38	18.01*	0.16	0.83	3.25	0.850
Investigating Agency	14.70*	5.57*	2.86	114.66*	0.13	0.33	0.31	0.481
Estimated Vehicle Speed	91.52*	4.65	0.27	944.89*	0.40	0.11	1.37	0.431
Number of Vehicles	7.05*	1.23	2.27	48.05*	0.23	0.10	1.79	0.429
City Size	5.14*	11.18*	1.25	70.52*	0.03	1.45	0.39	0.186
Person Behind Driver	1.14	6.46*	0.38	10.65*	0.05	0.05	0.40	0.152
Road Surface Condition	0.74	0.59	0.21	0.22	0.10	0.02	0.49	0.095
Alcohol Involvement	12.00*	107.94*	1.09	125.15*	0.01	2.18	0.42	0.068
Driver Sex	37.54*	84.63*	3.19	162.61*	0.01	1.77	0.11	0.064
Number of Occupants	10.61*	8.67*	1.32	9.94*	0.01	0.85	0.05	0.055
Accident Type	0.01	19.97*	0.40	30.97*	0.19	0.85	0.05	0.055
Weather	0.99	0.01	0.97	0.14	1.50	1.38	0.03	0.049

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: vehicle weight, manufacturer, adjusted vehicle speed, road classification and estimated vehicle speed. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

TABLE 3-22

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE
NORTH CAROLINA 1975

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Vehicle Weight	2703.51*	2045.25*	19.53*	59.41*	9.52*	3.12	1.89	6.839
Driver Sex	30.96*	68.30*	21.92*	252.47*	0.92	1.40	1.40	2.885
Manufacturer	256.11*	591.66*	42.52*	32.09*	8.73*	0.88	0.83	2.783
Driver Age	2495.82*	156.41*	55.57*	18.32*	2.84	0.42	2.48	2.177
Estimated Vehicle Speed	78.69*	4.72	11.79*	1080.69*	2.47	0.38	4.60	1.965
Adjusted Vehicle Speed	7.12*	4.70	6.52*	1156.18*	1.27	0.24	4.58	1.233
City Size	1.27	42.89*	5.22*	20.40*	2.08	1.04	0.23	1.024
Road Classification	25.24*	22.65*	6.78*	125.68*	1.45	1.44	0.16	0.890
Number of Occupants	1.14	21.26*	0.31	1.97	0.61	0.43	3.22	0.784
Number of Vehicles	8.61*	0.14	0.91	73.69*	0.41	0.76	3.50	0.564
Weather	1.56	0.32	0.13	5.18*	2.06	1.38	1.99	0.524
Investigating Agency	11.42*	11.21*	5.28*	147.78*	0.50	0.08	0.80	0.435
Accident Type	0.54	19.98*	0.09	23.48*	0.03	0.11	3.28	0.126
Light Condition	91.84*	9.43*	3.95*	75.40*	0.69	0.03	0.02	0.083
Alcohol Involvement	18.29*	82.52*	10.33*	92.08*	3.17	4.03*	0.01	0.070
Restraint Usage	9.74*	581.03*	3.96*	11.51*	2.75	0.01	0.43	0.068
Road Surface Condition	2.71	2.20	0.01	3.81	0.23	2.21	0.21	0.064
Person Behind Driver	4.17*	5.82*	0.19	0.01	2.77	0.41	0.01	0.034

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: vehicle weight, manufacturer, driver age, estimated vehicle speed, adjusted vehicle speed and road classification. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

3.1.3 Analysis of Mass Accident Data

Following completion of the variable selection procedure, the analytical steps that remain are modeling, adjustment, computation of effectiveness and estimation of error. Each of these steps and the results are described in this subsection.

Modeling

The basic purpose of modeling is to attempt to control for and take into account confounding effects through smoothing the data and removing random variability. Separate log linear models were fit for each of the three injury dichotomies (KA/BCO, KAB/CO and KABC/O) for each state and year of mass accident data analyzed. Each model was fit to a table consisting of an injury dichotomy (Injury), model year related to Standard implementation (Prepost) and passenger car body style (Style) as well as those selected variables (usually 3 in number) discussed in Section 3.1.2.

A series of tables is presented that documents and summarizes the modeling process and the results obtained. Complete modeling information for Texas, New York and North Carolina is given in Appendix B. Models were fitted separately for the three years of Texas data, the single year of New York data and the three years of North Carolina data for each injury dichotomy (i.e., KA/BCO, KAB/CO and KABC/O). Specifically, the likelihood ratio (LR) chi-square values in Appendix B tables are derived from tests of marginal association of each effect (variable interaction term) in which the table is summed over all unspecified margins, after which the effect is tested to be zero. Chi-square values marked with an asterisk in the Appendix represent the actual effects specified in a given model. All other chi-square values denote specific effects included due to the hierarchical nature of the log-linear models.

The strategy used to fit models can be summarized as follows:

1. As many significant effects (in terms of their marginal association) as required are first specified in an attempt to derive a model with an optimal fit. Optimal fit refers to the situation in which the magnitude of the model's LR chi-square is roughly similar to its number of degrees of freedom.
2. Effects were either deleted or added to the model in a stepwise fashion until the deletion of any one effect would result in a significant worsening of the fit, whereas the addition of any single effect would not significantly improve the model's fit.

This approach represents a compromise between the two considerations of parsimony and goodness-of-fit.

For the convenience of the reader, the complete model fitting information given in Appendix B is summarized in this section in Tables 3-23 through 3-32. In these tables, only the marginal associations of directly specified model effects (those values with an asterisk in Appendix B) are included. Tables 3-23, 3-24 and 3-25 contain the results for each year of Texas data for the injury dichotomies KA/BCO, KAB/CO and KABC/O, respectively. Only those effects that are directly specified in at least one year are included in the table. A dash in the table indicates that the particular effect was not directly specified in the model for that year. The marginal association of directly specified model effects for all three injury dichotomies for the single year of New York data is given in Table 3-26. Finally, the results for North Carolina are given in Tables 3-27, 3-28 and 3-29 in a format analogous to the Texas model results.

In each of the above analyses, a model was fit to the entire drivers-only data set for a given state and year. Additionally, a separate data set was created for each year of Texas data in which only drivers in vehicles of model years from 1965 through 1971 were included. About two-thirds of the passenger cars are within this model year range. The reduced sample has the advantage of (1) including only those vehicles having model years reasonably close to the Standard implementation date, (2) eliminating very old cars, and (3) reducing the extent of confounding effects such as the market shift from 4-door to 2-door cars which took place over an extended period of years. Tables 3-30, 3-31 and 3-32 contain the directly specified model effects for each year of Texas 1965-1971 model year derived data for the injury dichotomies KA/BCO, KAB/CO and KABC/O. The corresponding full models are given in Appendix B.

TABLE 3-23

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KA vs BCO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	-	-	-	0.81	1	0.369	0.21	1	0.647
Injury x Prepost x City Size	-	-	-	26.62	2	0.000	-	-	-
Injury x Driver Age x City Size	16.67	4	0.002	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	148.76	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	205.77	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	104.71	4	0.000
Injury x Road Type x Driver Age	-	-	-	21.35	4	0.000	-	-	-
Prepost x Style x Driver Age	-	-	-	743.34	2	0.000	-	-	-
Prepost x Style x City Size	-	-	-	16.05	2	0.000	5.32	2	0.070
Prepost x City Size x Road Type	-	-	-	27.54	4	0.000	-	-	-
Prepost x City Size x Driver Age	-	-	-	3.44	4	0.487	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	59.92	4	0.000
Prepost x City Size x TAD	-	-	-	-	-	-	38.10	4	0.000
Prepost x Road Type x Driver Age	-	-	-	15.17	4	0.004	-	-	-
Style x Driver Age x City Size	61.38	4	0.000	-	-	-	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86	4	0.002
Accident Type x Driver Age x City Size	17.23	8	0.028	-	-	-	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98	8	0.000
Injury x Style x City Size x Driver Age	-	-	-	12.33	4	0.015	-	-	-
Prepost x Style x Accident Type x Driver Age	11.07	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60	4	0.032
Style x City Size x Road Type x Driver Age	-	-	-	18.15	8	0.020	-	-	-
Injury x Prepost x Style x Accident Type x City Size	11.59	4	0.021	-	-	-	-	-	-
SUMMARY OF MODEL	112.13	98	0.152	115.24	106	0.2537	141.42	122	00.1103

TABLE 3-24

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KAB vs CO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.68	1	0.408	-	-	-	14.58	1	0.000
Injury x Prepost x Accident Type	-	-	-	-	-	-	26.12	2	0.000
Injury x Prepost x Oriver Age	13.50	2	0.001	-	-	-	-	-	-
Injury x Style x City Size	-	-	-	-	-	-	1.10	2	0.578
Injury x Accident Type x TAO	-	-	-	-	-	-	242.48	4	0.000
Injury x City Size x Road Type	-	-	-	178.00	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	353.53	4	0.000
Injury x City Size x TAO	-	-	-	-	-	-	54.50	4	0.000
Injury x Road Type x Oriver Age	-	-	-	26.35	4	0.000	-	-	-
Prepost x Style x City Size	12.39	2	0.002	16.07	2	0.000	5.32	2	0.070
Prepost x City Size x Road Type	-	-	-	27.52	4	0.000	-	-	-
Prepost x Road Type x Oriver Age	-	-	-	15.17	4	0.004	-	-	-
Style x Oriver Age x City Size	61.37	4	0.000	-	-	-	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86	4	0.002
City Size x Accident Type x TAO	-	-	-	-	-	-	510.98	8	0.000
Injury x Prepost x Accident Type x City Size	9.94	4	0.041	-	-	-	-	-	-
Injury x Prepost x Style x Oriver Age	-	-	-	14.32	2	0.001	-	-	-
Injury x Prepost x City Size x Oriver Age	-	-	-	10.34	4	0.035	-	-	-
Injury x Style x Accident Type x City Size	17.38	4	0.002	-	-	-	-	-	-
Inj. x Acc. Type x Oriver Age x City Size	23.20	8	0.003	-	-	-	-	-	-
Prepost x Style x Accident Type x Oriver Age	11.07	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAO	-	-	-	-	-	-	10.60	4	0.032
Style x City Size x Road Type x Oriver Age	-	-	-	18.15	8	0.020	-	-	-
SUMMARY OF MOOEL	91.50	96	0.6108	118.89	104	0.1508	129.82	116	0.1794

TABLE 3-25

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KABC vs O TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.46	1	0.496	0.26	1	0.608	13.40	1	0.000
Injury x Prepost x Driver Age	19.15	2	0.000	-	-	-	-	-	-
Prepost x Style x Driver Age	-	-	-	743.34	2	0.000	-	-	-
Prepost x Style x City Size	12.39	2	0.002	16.07	2	0.000	5.32	2	0.070
Prepost x City Size x Road Type	-	-	-	27.52	4	0.000	-	-	-
Prepost x Road Type x Driver Age	-	-	-	15.17	4	0.004	-	-	-
Accident Type x Driver Age x City Size	17.25	8	0.028	-	-	-	-	-	-
Injury x Prepost x Accident Type x City Size	10.13	4	0.038	-	-	-	-	-	-
Injury x Prepost x City Size x Driver Age	-	-	-	11.68	4	0.020	-	-	-
Injury x Style x Accident Type x City Size	12.66	4	0.013	-	-	-	-	-	-
Injury x Style x Driver Age x City Size	10.97	4	0.027	-	-	-	-	-	-
Prepost x Style x Accident Type x Driver Age	11.05	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60	4	0.032
Injury x Style x City Size x Road Type x Driver Age	-	-	-	17.13	8	0.029	-	-	-
Injury x Prepost x City Size x Accident Type x TAD	-	-	-	-	-	-	17.95	8	0.022
SUMMARY OF MODEL	93.47	102	0.7149	82.05	74	0.2440	95.46	80	0.1144

TABLE 3-26

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR THE THREE INJURY DICHOTOMIES NEW YORK 1974 DRIVERS-ONLY SAMPLE

Effect	KA vs BCO		KAB vs CO		KABC vs O	
	LR χ^2	Prob.	LR χ^2	Prob.	LR χ^2	Prob.
Injury x Rd Cl	123.51	0.000	-	-	-	-
Injury x Age	57.11	0.000	-	-	95.39	0.000
Injury x Prepost x Style	6.64	0.010	9.99	0.002	5.92	0.015
Injury x Prepost x Rd Cl	-	-	-	-	9.68	0.008
Injury x Prepost x Mfg	7.67	0.022	15.12	0.001	10.31	0.006
Injury x Style x Rd Cl	-	-	8.67	0.013	-	-
Injury x Style x Age	-	-	10.40	0.006	-	-
Injury x Rd Cl x Age	-	-	-	-	9.61	0.048
Prepost x Rd Cl x Age	17.80	0.001	17.80	0.001	17.05	0.002
Style x Rd Cl x Age	23.69	0.000	23.69	0.000	23.49	0.000
Prepost x Style x Rd Cl x Mfg	13.00	0.011	13.00	0.011	13.33	0.010
Prepost x Style x Age x Mfg	13.70	0.008	13.70	0.008	13.85	0.008
SUMMARY OF MODEL	138.49	0.3321	133.98	0.3409	141.47	0.1637

Note: The degrees of freedom for the entire model are: KA-132, KAB-128, KABC-126.

TABLE 3-27

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KA vs BCO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Weight	-	-	-	44.87	2	0.000	17.47	2	0.000
Injury x Sex	-	-	-	-	-	-	4.00	1	0.046
Mfg x Est Speed	20.34	4	0.000	-	-	-	-	-	-
Injury x Prepost x Style	5.79	1	0.016	1.93	1	0.165	1.75	1	0.187
Injury x Weight x Est Speed	9.99	4	0.041	-	-	-	-	-	-
Prepost x Style x Est Speed	6.00	2	0.050	-	-	-	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96	1	0.000
Prepost x Weight x Sex	-	-	-	-	-	-	6.25	2	0.044
Prepost x Sex x Mfg	-	-	-	-	-	-	31.07	2	0.000
Prepost x Style x Weight x Mfg	75.99	4	0.000	88.20	4	0.000	78.61	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74	4	0.000
SUMMARY OF MODEL	102.56	152	0.264	34,49	30	0.262	88.83	77	0.168

TABLE 3-28

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KAB vs CO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x Est Speed	88.65	2	0.000	-	-	-	-	-	-
Mfg x Est Speed	20.32	4	0.000	-	-	-	-	-	-
Injury x Prepost x Style	0.47	1	0.494	6.87	1	0.009	2.32	1	0.127
Injury x Prepost x Weight	-	-	-	-	-	-	8.81	2	0.012
Injury x Weight x Mfg	-	-	-	10.65	4	0.031	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06	2	0.000
Injury x Prepost x Weight x Est Spd	11.33	4	0.023	-	-	-	-	-	-
Prepost x Style x Weight x Mfg	75.98	4	0.000	88.20	4	0.000	78.60	4	0.000
Injury x Weight x Sex x Mfg	-	-	-	-	-	-	12.34	4	0.015
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74	4	0.000
SUMMARY OF MODEL	161.69	142	0.124	29.60	24	0.198	67.07	63	0.400

TABLE 3-29

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KABC vs O NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Weight	70.55	2	0.000	109.44	2	0.000	75.72	2	0.000
Injury x Est Speed	918.70	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	249.97	1	0.000
Weight x Est Speed	28.88	4	0.000	-	-	-	-	-	-
Mfg x Est Speed	20.32	4	0.000	-	-	-	-	-	-
Injury x Prepost x Style	2.01	1	0.157	6.97	1	0.008	0.06	1	0.811
Injury x Prepost x Mfg	-	-	-	-	-	-	7.65	2	0.022
Prepost x Style x Est Speed	6.00	2	0.050	-	-	-	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06	2	0.000
Prepost x Style x Weight x Mfg	75.98	4	0.000	88.20	4	0.000	78.60	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74	4	0.000
SUMMARY OF MODEL	174.60	156	0.147	29.51	30	0.491	76.34	75	0.435

TABLE 3-30

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS
FOR INJURY DICHOTOMY KA vs BCO MODEL YEARS 1965-1971
TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Driver Age	3.59	2	0.166	-	-	-	-	-	-
Style x TAD	-	-	-				106.61	2	0.000
Injury x Prepost x Style	0.42	1	0.518	0.06	1	0.804	0.14	1	0.705
Injury x Prepost x City Size	-	-	-	17.93	2	0.000	-	-	-
Injury x Style x Accident Type	-	-	-	-	-	-	6.35	2	0.042
Injury x City Size x Road Type	-	-	-	84.48	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	123.71	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	69.86	4	0.000
Prepost x Style x Driver Age	280.18	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	7.23	2	0.267	12.57	2	0.002	6.90	2	0.032
Prepost x Accident Type x Driver Age	12.56	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x City Size	17.13	4	0.002	-	-	-	13.13	4	0.011
Prepost x City Size x Road Type	-	-	-	13.10	4	0.011	-	-	-
Prepost x City Size x TAD	-	-	-	-	-	-	12.08	4	0.017
Style x Accident Type x Driver Age	20.51	4	0.000	-	-	-	-	-	-
Style x Driver Age x City Size	41.69	4	0.000	65.71	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51	8	0.000
Injury x Style x Accident Type x City Size	17.81	4	0.001	-	-	-	-	-	-
Injury x Prepost x Accident Type x TAD	-	-	-	-	-	-	10.94	4	0.027
SUMMARY OF MODEL	147.04	134	0.2083	148.72	144	0.3766	132.00	126	0.3393

TABLE 3-31

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS
FOR INJURY DICHOTOMY KAB vs CO MODEL YEARS 1965-1971
TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x TAD	-	-	-	-	-	-	110.61	2	0.000
Injury x Prepost x Style	0.14	1	0.707	0.68	1	0.409	7.93	1	0.005
Injury x Prepost x City Size	15.99	2	0.000	19.80	2	0.000	12.41	2	0.002
Injury x Prepost x Oriver Age	-	-	-	11.98	2	0.002	-	-	-
Injury x Style x Accident Type	-	-	-	-	-	-	9.15	2	0.010
Injury x Style x Driver Age	5.86	2	0.053	9.77	2	0.008	-	-	-
Injury x Accident Type x TAO	-	-	-	-	-	-	154.15	4	0.000
Injury x Driver Age x City Size	28.43	4	0.000	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	116.13	2	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	195.01	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	41.52	4	0.000
Injury x Road Type x Driver Age	-	-	-	19.58	4	0.001	-	-	-
Prepost x Style x Accident Type	29.14	2	0.000	-	-	-	8.55	2	0.014
Prepost x Style x Driver Age	280.18	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	7.23	2	0.027	12.57	2	0.002	6.92	2	0.031
Prepost x Accident Type x Driver Age	12.56	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x TAO	-	-	-	-	-	-	23.03	4	0.000
Prepost x City Size x Road Type	-	-	-	13.10	4	0.011	-	-	-
Prepost x City Size x Accident Type	17.13	4	0.002	-	-	-	13.12	4	0.011
Style x Accident Type x Oriver Age	20.51	4	0.000	-	-	-	-	-	-
Style x Driver Age x City Size	41.69	4	0.000	65.71	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51	8	0.000
Injury x Style x Accident Type x City Size	12.78	4	0.012	-	-	-	-	-	-
SUMMARY OF MODEL	130.56	126	0.3722	146.17	134	0.2228	155.25	136	0.1237

TABLE 3-32

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS
FOR INJURY DICHOTOMY KABC vs O MODEL YEARS 1965-1971
TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x TAD	-	-	-	-	-	-	110.61	2	0.000
Injury x Prepost x Style	-	-	-	3.09	1	0.079	6.02	1	0.014
Injury x Prepost x City Size	-	-	-	13.06	2	0.002	-	-	-
Injury x Style x Accident Type	-	-	-	-	-	-	7.35	2	0.025
Injury x Style x Driver Age	9.51	2	0.009	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	149.11	4	0.000
Injury x Oriver Age x City Size	23.88	4	0.000	-	-	-	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	150.86	4	0.000
Injury x City Size x TAO	-	-	-	-	-	-	32.97	4	0.000
Prepost x Style x Accident Type	-	-	-	-	-	-	8.55	2	0.014
Prepost x Style x Oriver Age	280.18	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	-	-	-	12.57	2	0.002	6.90	2	0.032
Prepost x Accident Type x Oriver Age	12.56	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03	4	0.000
Prepost x City Size x Road Type	-	-	-	13.09	4	0.011	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	13.12	4	0.011
Style x Accident Type x Oriver Age	20.51	4	0.000	-	-	-	-	-	-
Style x Driver Age x City Size	41.69	4	0.000	-	-	-	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51	8	0.000
Inj.x Prepost x Style x Acc.Type x City Size	10.81	4	0.029	-	-	-	-	-	-
Inj.x Style x City Size x Rd. Type x Dr.Age	-	-	-	20.33	8	0.009	-	-	-
SUMMARY OF MODEL	119.69	108	0.2079	92.81	88	0.3422	148.45	138	0.2566

Adjustment of Data

Prior to computing the actual effectiveness values, the smoothed data were adjusted so as to allow for the direct comparison of injury rates. Such adjustment is necessary in order to insure that the overall effectiveness estimate will not be affected by a potentially different distribution of 2-door and 4-door vehicles across all levels of the relevant pre-crash factors identified through the variable selection procedure (described in Section 3.1.2). The data were adjusted so that the following constraints were satisfied (notation is explained in Figure 3-2).

Constraint 1. The Pre-Post Standard mix of 2-door cars shall be the same for all pre-crash conditions:

$$\frac{n'_{.11\ell}}{n'_{.12\ell}} = \frac{n_{.11.}}{n_{.12.}}$$

Constraint 2. The distribution of 2-door cars over all pre-crash conditions shall remain unchanged:

$$n'_{.1.\ell} = n_{.1.\ell}$$

Constraint 3. The Pre-Post Standard mix of 4-door cars shall be the same for all pre-crash conditions:

$$\frac{n'_{.21\ell}}{n'_{.22\ell}} = \frac{n_{.21.}}{n_{.22.}}$$

Constraint 4. The distribution of 4-door cars over all pre-crash conditions shall remain unchanged:

$$n'_{.2.\ell} = n_{.2.\ell}$$

Constraints 5-8. For each Pre-Post/2-4 door combination within each pre-crash condition, the injury risk shall not be changed:

$$\frac{n'_{1jk\ell}}{n'_{.jk\ell}} = \frac{n_{1jk\ell}}{n_{.jk\ell}}$$

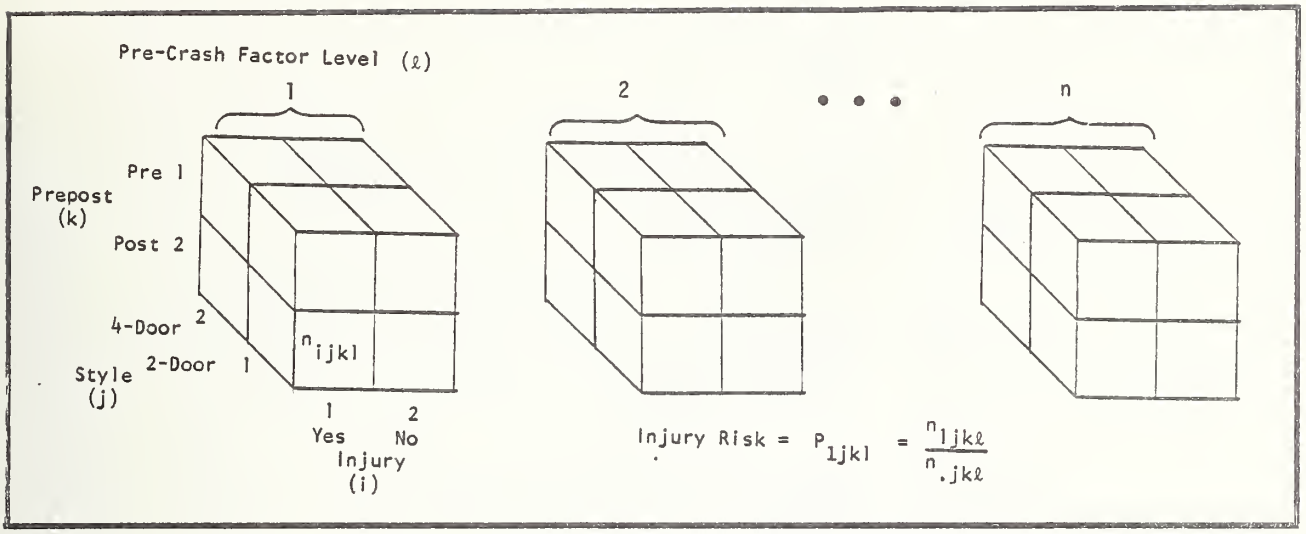

Figure 3-2. Summary of notation used in description of adjustment procedures.

As a first step in the adjustment procedure, the above constraints were satisfied by computing adjusted values (n') of the cell frequencies for the marginal sub-table representing the joint classification of the variables Pre-Post and Vehicle Body Style (2-door/4-door) within each level (ℓ) of the pre-crash conditions, as follows:

$$n'_{.11\ell} = \frac{(n_{.11.})(n_{.1.\ell})}{n_{.1..}}$$

$$n'_{.12\ell} = n_{.1.\ell} - n'_{.11\ell}$$

$$n'_{.21\ell} = \frac{(n_{.21.})(n_{.2.\ell})}{n_{.2..}}$$

$$n'_{.22\ell} = n_{.2.\ell} - n'_{.21\ell}$$

Next, in order to generate a complete table of adjusted values in which the variable Injury is explicitly represented, the adjusted marginal sub-totals computed in the previous step are decomposed into Injured/Uninjured categories by applying the original injury risk to the appropriate newly-adjusted marginal total, as follows:

$$n'_{111\ell} = \frac{n_{111\ell}}{n_{.11\ell}} (n'_{.11\ell})$$

$$n'_{211\ell} = \frac{n_{211\ell}}{n_{.11\ell}} (n'_{.11\ell})$$

$$n'_{121\ell} = \frac{n_{121\ell}}{n_{.21\ell}} (n'_{.21\ell})$$

$$n'_{221\ell} = \frac{n_{221\ell}}{n_{.21\ell}} (n'_{.21\ell})$$

$$n'_{112\ell} = \frac{n_{112\ell}}{n_{.12\ell}} (n'_{.12\ell})$$

$$n'_{212\ell} = \frac{n_{212\ell}}{n_{.12\ell}} (n'_{.12\ell})$$

$$n'_{122\ell} = \frac{n_{122\ell}}{n_{.22\ell}} (n'_{.22\ell})$$

$$n'_{222\ell} = \frac{n_{222\ell}}{n_{.22\ell}} (n'_{.22\ell})$$

After the cell frequencies were adjusted within each factor level, the data were aggregated over all factor levels, resulting in a single Injury x Prepost x Style table for each year of each state's data base. These latter tables of smoothed, adjusted data served as the basis for all subsequent effectiveness estimates.

As noted previously, proper adjustment of the data is necessary in order to allow for the direct comparison of injury rates. By following the procedure outlined in this section, such comparisons are not only possible, but the total number of drivers does not change, the effectiveness value within each factor level is not altered (nor is the corresponding odds ratio), but the various injury risks remain unchanged across all levels of pre-crash conditions. Table 3-33 contains the various pre-crash factors for each state and data year which served as the basis for the adjustment of the smoothed cell frequencies.

TABLE 3-33

VARIABLES USED IN ADJUSTMENT PROCEDURE

State	Year	Variables
Texas	1972	Accident Type Driver Age City Size
	1973	City Size Road Classification Driver Age
	1974	City Size Accident Type TAD
New York	1974	Road Classification Driver Age Manufacturer
North Carolina	1973	Vehicle Weight Manufacturer Estimated Vehicle Speed
	1974	Vehicle Weight Manufacturer
	1975	Vehicle Weight Driver Sex Manufacturer

Effectiveness and Error Estimation

Given the stochastic nature of the phenomenon under study, it is necessary to estimate the possible range of error for the results obtained. Using the notation depicted in Figure 3-3, the effectiveness of seat back locks in reducing driver injuries can be expressed as:

$$E = \left[1 - \left(\frac{p_{111}}{p_{121}} \times \frac{p_{122}}{p_{112}} \right) \right] \times 100$$

where $p_{ijk} = n_{ijk}/n_{.jk}$. Therefore, the problem at hand is one of deriving confidence limits for a double ratio of probabilities.

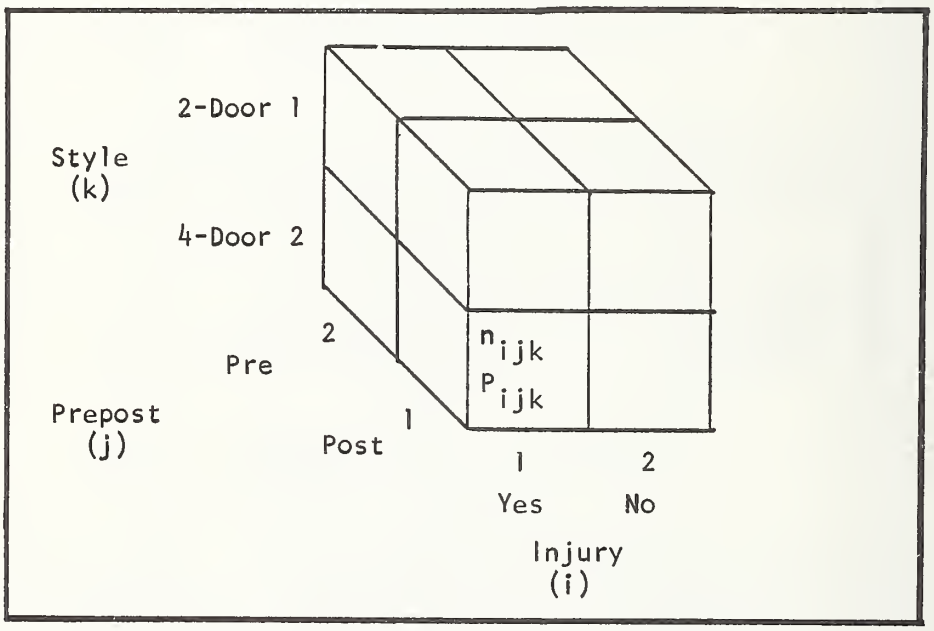

Figure 3-3. Basic contingency table for effectiveness computation and error estimation.

To estimate a confidence interval for R, where $R = \frac{p_{111}}{p_{121}} : \frac{p_{112}}{p_{122}} = \frac{p_{111}\, p_{122}}{p_{121}\, p_{112}}$, it is assumed that both the p_{1jk} and n_{1jk} terms are binomially distributed random variables. By defining $R = \frac{\pi_{111}\, \pi_{122}}{\pi_{121}\, \pi_{112}} \times \frac{(1 + \varepsilon_{111})(1 + \varepsilon_{122})}{(1 + \varepsilon_{121})(1 + \varepsilon_{112})}$ where the π_{ijk}'s are

the expected values of the p_{ijk}'s, one can study the $\frac{(1 + \varepsilon_{111})(1 + \varepsilon_{122})}{(1 + \varepsilon_{121})(1 + \varepsilon_{112})}$ term by expanding the fraction in power series in ε_{121} and ε_{112}. These series expressions hold only if $|\varepsilon_{ijk}| < 1$. Hence, p_{1jk} should be restricted to the range $0 \ldots 2\pi_{1jk}$, or n_{1jk} to the range $0 \ldots 2n_{1jk}\pi_{1jk}$. Since $\sigma(n_{1jk}) = \sqrt{n_{.jk}\pi_{1jk}(1 - \pi_{1jk})}$, there is a $\pm 2\sigma$ range for $n_{.jk}\pi_{1jk} = 4(1 - \pi_{1jk})$. Since $n_{.jk}\pi_{1jk}$ is always much larger than 4 in the analyses reported here, this restriction is never violated in this study.

Since in all cases the $n_{.ij}p_{1ij}$ terms are well over 100, a second order approximation to the first and second moments, using a normal distribution to estimate the "true" mean and variance of R, was employed in CEM's error estimation procedure. Furthermore, since the expected value of R overestimates the effectiveness 1 - R, the bias in R was corrected, however small it may have been. A more detailed description of the error estimation procedure used, along with its rationale, is summarized in Appendix D. The actual formulas used in the present study are outlined below, using the notation depicted in Figure 3-2:

$$\text{Var (E)} = \left(\frac{p_{111}\,p_{122}}{p_{121}\,p_{112}}\right)^2\left(\frac{1 - p_{111}}{n_{.11}\,p_{111}} + \frac{1 - p_{121}}{n_{.21}\,p_{121}} + \frac{1 - p_{112}}{n_{.12}\,p_{112}} + \frac{1 - p_{122}}{n_{.22}\,p_{122}}\right)$$

$$\text{unbiased (E)} = [1 - (r'xy)] \cdot 100,$$

where $r' = \frac{p_{111}\,p_{122}}{p_{121}\,p_{112}}$,

$$x = 1 + \frac{1 - p_{121}}{n_{.21}\,p_{121}} - \frac{(1 - p_{121})(1 - 2p_{121})}{(n_{.21}\,p_{121})^2} + \left[\frac{3(1 - p_{121})^2}{n_{.21}\,p_{121}} + \frac{(1 - p_{121})(1 - 6p_{121}(1 - p_{121}))}{(n_{.21}\,p_{121})^3}\right]$$

$$y = 1 + \frac{1 - p_{112}}{n_{.12}\,p_{112}} - \frac{(1 - p_{112})(1 - 2p_{112})}{(n_{.12}\,p_{112})^2} + \left[\frac{3(1 - p_{112})^2}{n_{.12}\,p_{112}} + \frac{(1 - p_{112})(1 - 6p_{112}(1 - p_{112}))}{(n_{.12}\,p_{112})^3}\right]$$

In all cases, a 95 percent probability level ($\alpha = 0.05$) was used in constructing confidence intervals.

With the above discussion of the effectiveness computation and error estimation procedure in mind, we can now discuss the effectiveness results obtained. The results are presented in a series of computer-generated tables that provide the injury distributions for 2-door/4-door cars both Pre- and Post-Standard, the injury probabilities for these categories and the effectiveness with an associated standard deviation and confidence interval. These statistics are presented for the KA/BCO, KAB/CO and KABC/O injury dichotomies.* All of the effectiveness results presented in this section are obtained from either observed, unadjusted contingency table data or from smoothed (modeled) adjusted contingency table data. Only a summary of effectiveness values computed for observed, unadjusted data is given in this section; more detail is provided in Appendix C.

The effectiveness results for smoothed,adjusted data for Texas are presented in Tables 3-34, 3-35 and 3-36. The results for New York are in Table 3-37, and those for North Carolina are shown in Tables 3-38, 3-39 and 3-40. Finally, the effectiveness results for the Texas 1965-1971 model year sample are in Tables 3-41, 3-42 and 3-43. While a number of qualifying comments and interpretations need to be made, the results do not support the hypothesis that the introduction of seat back locks in 2-door cars reduces the injury risk to drivers in these cars. That is, the results do not demonstrate that this aspect of the Standard has been effective in reducing injury.

The effectiveness results obtained are summarized in Table 3-44 and Table 3-45 for observed, unadjusted mass accident data and smoothed, adjusted data, respectively. On the average, the net impact of modeling and adjustment was to increase the value of effectiveness estimates by roughly two to three percent.

The effectiveness values computed for the smoothed, adjusted data are most often negative. In Texas, the largest sample, effectiveness ranged from 4.9 percent to -12.7 percent for KA/BCO; -1.3 percent to -10.3 percent for KAB/CO; and -0.7 percent to -8.3 percent for KABC/O. The effectiveness values computed from the New York 1974 sample were negative for all three injury dichotomies (-7.2 percent to -17.9 percent). In North Carolina, the effectiveness was negative in 1973 and 1974 for all three injury dichotomies and positive in 1975.

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*Definitions of injury levels are: K = killed; A = severely injured; B = moderately injured; C = minor injuries; O = no injury.

TABLE 3-34

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS
EXPECTED, ADJUSTED
TOTAL CASES = 159700

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	2 - DOOR %	2 - DOOR POST	2 - DOOR %	4 - DOOR PRE	4 - DOOR %	4 - DOOR POST	4 - DOOR %	ROW TOTAL	ROW PCT
K+A	977	0.6	1145	0.7	1149	0.7	698	0.4	3969	2.5
B+C+O	30026	18.8	54504	34.1	37655	23.6	33546	21.0	155731	97.5
K+A+B	3001	1.9	4065	2.5	3509	2.2	2308	1.4	12883	8.1
C+O	28002	17.5	51583	32.3	35295	22.1	31937	20.0	146817	91.9
K+A+B+C	4181	2.6	6025	3.8	4866	3.0	3395	2.1	18467	11.6
O	26821	16.8	49628	31.1	33938	21.3	30847	19.3	141234	88.4
K+A+B+C+O	31003	19.4	55649	34.8	38804	24.3	34244	21.4	159700	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	4.92	6.09	-5.06	14.91
K+A+B	-1.33	3.50	-7.07	4.42
K+A+B+C	-1.58	2.87	-6.29	3.14

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	3.15	2.06	2.96	2.04	2.49
K+A+B	9.68	7.30	9.04	6.74	8.07
K+A+B+C	13.49	10.83	12.54	9.91	11.56

TABLE 3-35

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS
EXPECTED, ADJUSTED
TOTAL CASES = 161915

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	752	0.5	1299	0.8	942	0.6	694	0.4	3687	2.3
B+C+O	24297	15.0	64755	40.0	30342	18.7	38834	24.0	158228	97.7
K+A+B	2607	1.6	4704	3.0	2951	1.8	2509	1.5	12851	7.9
C+O	22440	13.9	61272	37.8	28333	17.5	37019	22.9	149064	92.1
K+A+B+C	3560	2.2	7153	4.4	4034	2.5	3860	2.4	18607	11.5
O	21485	13.3	58904	36.4	27247	16.8	35667	22.0	143303	88.5
K+A+B+C+O	25049	15.5	66054	40.8	31284	19.3	39528	24.4	161915	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-12.65	7.56	-25.04	-0.26
K+A+B	-5.48	3.62	-9.41	2.45
K+A+B+C	-0.65	2.87	-5.35	4.06

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	3.00	1.97	3.01	1.76	2.28
K+A+B	10.41	7.24	9.43	6.35	7.94
K+A+B+C	14.21	10.83	12.90	9.77	11.49

TABLE 3-36

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS
EXPECTED, ADJUSTED
TOTAL CASES = 146451

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	492	0.3	1199	0.8	548	0.4	618	0.4	2857	2.0
B+C+O	17777	12.1	65892	45.0	22413	15.3	37512	25.6	143594	98.0
K+A+B	1762	1.2	5065	3.5	2114	1.4	2493	1.7	11434	7.8
C+O	16511	11.3	62026	42.4	20846	14.2	35634	24.3	135017	92.2
K+A+B+C	2404	1.6	7651	5.2	2962	2.0	3940	2.7	16957	11.6
O	15867	10.8	59437	40.6	20004	13.7	34189	23.3	129497	88.4
K+A+B+C+O	18269	12.5	67091	45.8	22961	15.7	38130	26.0	146451	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	1.93	7.71	-10.70	14.57
K+A+B	-10.34	4.28	-17.36	-3.33
K+A+B+C	-8.25	3.42	-13.86	-2.63

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	2.69	1.79	2.39	1.62	1.95
K+A+B	9.64	7.55	9.21	6.54	7.81
K+A+B+C	13.16	11.40	12.90	10.33	11.58

TABLE 3-37

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 NEW YORK
EXPECTED, ADJUSTED
TOTAL CASES = 62850

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	563	0.9	2056	3.3	411	0.7	693	1.1	3723	5.9
B+C+O	6360	10.1	32917	52.4	5180	8.3	14662	23.3	59127	94.1
K+A+B	1668	2.7	6594	10.5	1252	2.0	2401	3.8	11915	19.0
C+O	5257	8.4	28377	45.2	4343	6.9	12952	20.6	50929	81.0
K+A+B+C	2532	4.0	11025	17.5	1926	3.1	4250	6.7	19733	31.3
O	4425	7.0	24106	38.2	3700	5.9	11171	17.7	43402	68.7
K+A+B+C+O	6923	11.0	34973	55.6	5599	8.9	15355	24.4	62850	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-17.93	8.93	-32.57	-3.29
K+A+B	-12.10	4.42	-19.35	-4.86
K+A+B+C	-7.15	3.08	-12.20	-2.11

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	8.13	5.88	7.34	4.51	5.92
K+A+B	24.09	18.86	22.38	15.64	18.96
K+A+B+C	36.59	31.38	34.23	27.56	31.26

TABLE 3-38

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 N. CAROLINA
EXPECTED, ADJUSTED
TOTAL CASES = 25898

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	126	0.5	253	1.0	125	0.5	141	0.5	645	2.5
B+C+O	4377	16.9	10007	38.6	3822	14.8	7047	27.2	25253	97.5
K+A+B	473	1.8	876	3.4	365	1.4	523	2.0	2237	8.6
C+O	4035	15.6	9387	36.2	3584	13.8	6664	25.7	23670	91.4
K+A+B+C	733	2.8	1520	5.9	625	2.4	962	3.7	3840	14.8
O	3771	14.6	8743	33.8	3324	12.8	6227	24.0	22065	85.2
K+A+B+C+O	4503	17.4	10260	39.6	3947	15.2	7188	27.8	25898	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-44.38	23.47	-82.87	-5.89
K+A+B	-3.70	8.81	-18.14	10.74
K+A+B+C	-7.85	6.78	-18.98	3.27

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.80	2.47	3.17	1.96	2.49
K+A+B	10.49	8.54	9.24	7.28	8.63
K+A+B+C	16.27	14.81	15.83	13.38	14.82

TABLE 3-39

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 N. CAROLINA
EXPECTED,ADJUSTED
TOTAL CASES = 26539

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	95	0.4	258	1.0	92	0.3	158	0.6	603	2.3
B+C+O	3607	13.6	10978	41.4	3480	13.1	7871	29.7	25936	97.7
K+A+B	368	1.4	1002	3.8	324	1.2	547	2.1	2241	8.4
C+O	3335	12.6	10233	38.6	3249	12.2	7481	28.2	24298	91.6
K+A+B+C	612	2.3	1768	6.7	573	2.2	1073	4.0	4026	15.2
O	3091	11.6	9465	35.7	2998	11.3	6956	26.2	22510	84.8
K+A+B+C+O	3702	13.9	11236	42.3	3572	13.5	8029	30.3	26539	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-19.04	20.90	-53.32	15.23
K+A+B	-19.93	10.64	-37.38	-2.48
K+A+B+C	-14.59	7.35	-26.64	-2.54

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.57	2.30	2.58	1.97	2.27
K+A+B	9.94	8.92	9.07	6.81	8.44
K+A+B+C	16.53	15.74	16.05	13.36	15.17

TABLE 3-40

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1975 N. CAROLINA
EXPECTED,ADJUSTED
TOTAL CASES = 28233

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	95	0.3	255	0.9	64	0.2	185	0.7	597	2.1
B+C+O	3276	11.6	12097	42.8	3232	11.4	9031	32.0	27636	97.9
K+A+B	366	1.3	1020	3.6	293	1.0	734	2.6	2413	8.5
C+O	3005	10.6	11332	40.1	3004	10.6	8483	30.0	25822	91.5
K+A+B+C	609	2.2	1934	6.8	527	1.9	1355	4.8	4425	15.7
O	2762	9.8	10421	36.9	2770	9.8	7865	27.8	23818	84.3
K+A+B+C+O	3369	11.9	12352	43.8	3296	11.7	9216	32.6	28233	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	26.52	13.73	4.00	49.03
K+A+B	14.86	7.47	2.61	27.11
K+A+B+C	5.57	5.98	-4.23	15.38

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	2.76	2.06	1.94	2.01	2.11
K+A+B	10.66	8.26	8.89	7.96	8.55
K+A+B+C	18.07	15.65	15.98	14.70	15.67

TABLE 3-41

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS 65-71
EXPECTED,ADJUSTED
TOTAL CASES = 109146

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	534	0.5	928	0.9	458	0.4	593	0.5	2513	2.3
B+C+O	17898	16.4	44226	40.5	16350	15.0	28159	25.8	106633	97.7
K+A+B	1639	1.5	3278	3.0	1395	1.3	1943	1.8	8255	7.6
C+O	16795	15.4	41877	38.4	15411	14.1	26806	24.6	100889	92.4
K+A+B+C	2348	2.2	4838	4.4	1989	1.8	2872	2.6	12047	11.0
O	16085	14.7	40315	36.9	14819	13.6	25874	23.7	97093	89.0
K+A+B+C+O	18432	16.9	45154	41.4	16808	15.4	28752	26.3	109146	100.0

EFFECTIVENESS VALLES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	5.95	7.68	-6.64	18.54
K+A+B	-0.38	4.47	-7.70	6.94
K+A+B+C	0.30	3.62	-5.63	6.23

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	2.90	2.06	2.72	2.06	2.30
K+A+B	8.89	7.26	8.30	6.76	7.56
K+A+B+C	12.74	10.71	11.83	9.99	11.04

TABLE 3-42

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS 65-71
EXPECTED, ADJUSTED
TOTAL CASES = 101848

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	425	0.4	857	0.8	404	0.4	527	0.5	2213	2.2
B+C+O	15456	15.2	41759	41.0	14965	14.7	27455	27.0	99635	97.8
K+A+B	1561	1.5	3130	3.1	1323	1.3	1826	1.8	7840	7.7
C+O	14318	14.1	39486	38.8	14043	13.8	26154	25.7	94001	92.3
K+A+B+C	2167	2.1	4648	4.6	1846	1.8	2819	2.8	11480	11.3
O	13712	13.5	37967	37.3	13525	13.3	25159	24.7	90363	88.7
K+A+B+C+O	15881	15.6	42616	41.8	15369	15.1	27982	27.5	101848	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-5.32	9.25	-20.49	9.85
K+A+B	1.32	4.50	-6.06	8.71
K+A+B+C	4.67	3.55	-1.15	10.49

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.68	2.01	2.63	1.88	2.17
K+A+B	9.83	7.34	8.61	6.53	7.70
K+A+B+C	13.65	10.91	12.01	10.08	11.27

TABLE 3-43

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS 65-71
EXPECTED,ADJUSTED
TOTAL CASES = 85110

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	320	0.4	656	0.8	284	0.3	414	0.5	1674	2.0
B+C+O	11937	14.0	35706	42.0	11909	14.0	23884	28.1	83436	98.0
K+A+B	1163	1.4	2847	3.3	1105	1.3	1649	1.9	6764	7.9
C+O	11093	13.0	33519	39.4	11086	13.0	22648	26.6	78346	92.1
K+A+B+C	1610	1.9	4271	5.0	1553	1.8	2585	3.0	10019	11.8
O	10643	12.5	32091	37.7	10642	12.5	21715	25.5	75091	88.2
K+A+B+C+O	12257	14.4	36362	42.7	12193	14.3	24298	28.5	85110	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	5.02	9.67	-10.84	20.89
K+A+B	-10.33	5.51	-19.36	-1.30
K+A+B+C	-7.11	4.36	-14.26	0.04

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	2.61	1.80	2.33	1.70	1.97
K+A+B	9.49	7.83	9.06	6.79	7.95
K+A+B+C	13.14	11.75	12.73	10.64	11.77

TABLE 3-44

SUMMARY OF PERCENT EFFECTIVENESS FOR OBSERVED UNADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval	
					From	To
KA	Texas	1972	5.1	6.1	-4.9	15.1
		1973	-6.7	7.2	-18.5	5.1
		1974	-2.8	8.0	-16.0	10.3
	New York	1974	-27.4	9.7	-43.2	-11.5
	North Carolina	1973	-49.8	24.0	-89.8	-9.8
		1974	-29.2	22.2	-65.7	7.3
		1975	20.1	14.6	-3.8	43.9
	Texas 1965-1971 Model Year Cars	1972	4.4	7.8	-8.3	17.17
		1973	-2.5	9.0	-17.3	12.3
		1974	3.2	9.8	-12.9	19.3
KAB	Texas	1972	-3.2	3.6	-9.1	2.6
		1973	-1.0	3.5	-6.8	4.8
		1974	-16.3	4.5	-23.6	-9.0
	New York	1974	-14.6	4.5	-22.0	-7.3
	North Carolina	1973	-6.8	9.1	-21.6	8.1
		1974	-26.9	11.1	-45.0	-8.7
		1975	12.0	7.7	-0.7	24.7
	Texas 1965-1971 Model Year Cars	1972	-1.8	4.5	-9.2	5.5
		1973	3.4	4.4	-3.9	10.6
		1974	-15.4	5.7	-24.8	-6.0
KABC	Texas	1972	-2.3	2.9	-7.1	2.5
		1973	1.2	2.8	-3.4	5.9
		1974	-12.5	3.5	-18.2	-6.7
	New York	1974	-8.3	3.1	-13.4	-3.2
	North Carolina	1973	-9.7	6.9	-21.0	1.5
		1974	-18.9	7.5	-31.2	-6.5
		1975	1.2	6.2	-9.1	11.4
	Texas 1965-1971 Model Year Cars	1972	-0.7	3.6	-6.7	5.2
		1973	6.0	3.5	0.3	11.8
		1974	-10.7	4.5	-18.1	-3.4

TABLE 3-45

SUMMARY OF PERCENT EFFECTIVENESS FOR SMOOTHED ADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval	
					From	To
KA	Texas	1972	4.9	6.1	-5.1	14.9
		1973	-12.7	7.6	-25.0	-0.3
		1974	1.9	7.7	-10.7	14.6
	New York	1974	-17.9	8.9	-32.5	-3.3
	North Carolina	1973	-44.4	23.5	-82.9	-5.9
		1974	-19.0	20.9	-53.3	15.2
		1975	26.5	13.7	4.0	49.0
	Texas 1965-1971 Model Year Cars	1972	6.0	7.7	-6.6	18.5
		1973	-5.3	9.3	-20.5	9.9
		1974	5.0	9.7	-10.8	20.9
KAB	Texas	1972	-1.3	3.5	-7.1	4.4
		1973	-3.5	3.6	-9.4	2.5
		1974	-10.3	4.3	-17.4	-3.3
	New York	1974	-12.1	4.4	-19.4	-4.9
	North Carolina	1973	-3.7	8.8	-18.1	10.7
		1974	-19.9	10.6	-37.4	-2.5
		1975	14.9	7.5	2.6	27.1
	Texas 1965-1971 Model Year Cars	1972	-0.4	4.5	-7.7	6.9
		1973	1.3	4.5	-6.1	8.7
		1974	-10.3	6.5	-19.4	-1.3
KABC	Texas	1972	-1.6	2.9	-6.3	3.1
		1973	-0.7	2.9	-5.4	4.1
		1974	-8.3	3.4	-13.9	-2.6
	New York	1974	-7.2	3.1	-12.2	-2.1
	North Carolina	1973	-7.9	6.8	-19.0	3.3
		1974	-14.6	7.4	-26.6	-2.5
		1975	5.6	6.0	-4.2	15.4
	Texas 1965-1971 Model Year Cars	1972	0.3	3.6	-5.6	6.2
		1973	4.7	3.6	-1.2	10.5
		1974	-7.1	4.4	-14.3	0.0

The results of the analyses are consistent with the null hypothesis that the introduction of seat back locks in 2-door passenger cars had no effect on the injury risk to drivers in these cars. That is, the results do not demonstrate that this aspect of the Standard has been effective in reducing injury. In conjunction with this basic conclusiosn, the following observations are made.

- A comparison of the effectiveness results obtained for the observed (raw) unadjusted data with the smoothed (modeled) adjusted data shows that usually a greater effectiveness is obtained with the smoothed adjusted data. In the observed data, the reduction in injury rates from Pre-Standard to Post-Standard cars is greater for 4-door cars than for 2-door cars. Thus, modeling and adjustment to remove confounding effects does increase effectiveness; however, in most cases, negative values remain, implying that not all confounding effects have been removed (presuming that the introduction of seat back locks does not, in fact, increase injury risk).
- The variability in results among years is greater in North Carolina with the small data base than in Texas with its much larger number of cases.
- The attempt to reduce or eliminate unexplained confounding effects by restricting the sample of cases to drivers occupying passenger cars with model years from 1965 to 1971 yielded results that are very similar when compared with the full Texas sample.

The failure to find positive effectiveness for injury reduction to drivers of 2-door cars precludes the carrying out of the final step in the analysis, which would have been to extrapolate the results based on Texas, North Carolina and New York analyses to nationwide estimates of the number of injuries avoided.

It is recognized that the above analyses may have been adversely affected by unidentified or unreported confounding effects. Certainly the possibility exists that other Standards being implemented during the late Sixties and early Seventies were differentially applied or had significantly greater effectiveness in 2-door or 4-door cars. Then, differences in the reduction of injury rates might be more directly related to these factors than the introduction of seat back locks. Additionally, the pronounced increase in preference for 2-door cars during the late Sixties and early Seventies may vary significantly among the buying and driving population. While driver age, driver sex, vehicle weight and manufacturer are all variables chosen for modeling and adjustment, it is by no means certain that all potential confounding effects can be accounted for. For example, the profile of driver characteristics for drivers of 2-door subcompact cars compared to drivers of 4-door full size cars may reflect socioeconomic and personality factors that are not adequately accounted for by the variables analyzed to remove confounding effects.

3.2 Analysis of Rear Seat Occupant Fatalities

3.2.1 Background

The purpose of this analysis is to assess whether the requirement for seat back locks for folding front seat backs in 2-door passenger cars increases the number of fatalities among rear seat occupants in crashes which involve fire/explosion or immersion. It has been suggested that the difficulty of finding and/or operating a seat back lock release in a panic situation, such as post-crash fire or immersion, could lead to increased rear seat occupant fatalities.

3.2.2 Data

The data were derived from the Fatal Accident Reporting System (FARS) for 1975, 1976, 1977 and 1978. Table 3-46 shows that there were 3601 passengers in fire/explosion and immersion accidents in FARS, and that 89 percent of the passengers were in vehicles involving fire/explosion, while 11 percent of the passengers were in immersed vehicles. Also, the frequency of front seat and rear seat passengers was essentially identical in both types of accidents (86 percent and 14 percent, respectively).*

TABLE 3-46

SEATING POSITION OF PASSENGERS IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

(Source: FARS 1975, 1976, 1977, 1978)

Passenger Location	Fire/Explosion		Immersion		Total	
	Number	%	Number	%	Number	%
Front Seat	2741	85.7	347	85.9	3088	85.8
Rear Seat	456	14.3	57	14.1	513	14.2
Total Passengers	3197	100	404	100	3601	100
Percent	88.8		11.2		100	

*The rear seat occupancy levels in these FARS cases are about 50 percent higher than those encountered in all accidents, based on North Carolina data for 1973, 1974, 1975, 1976 [3].

Table 3-47 shows the injury distributions for 513 rear seat passengers in fire/explosion and immersion FARS cases. The fatality rate for this biased set of data is 44 percent for both fire/explosion and immersion. In contrast, Table 3-48 indicates that the fatality rate for 3088 front seat passengers in fire/explosion and immersion in FARS cases is much greater than for rear seat passengers: 50 percent higher in fire/explosion and 75 percent higher in immersion.

TABLE 3-47

INJURY DISTRIBUTIONS FOR REAR SEAT PASSENGERS IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

(Source: FARS 1975, 1976, 1977, 1978)

Injury Status	Fire/Explosion		Immersion		Total	
	Number	%	Number	%	Number	%
Not Injured	15	3.3	11	19.3	26	5.1
Killed	202	44.3	25	43.8	227	44.2
A	143	31.4	7	12.3	150	29.2
B	79	17.3	7	12.3	86	16.8
C	17	3.7	7	12.3	24	4.7
Total Occupants	456	100	57	100	513	100

TABLE 3-48

INJURY DISTRIBUTIONS FOR FRONT SEAT PASSENGERS IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

(Source: FARS 1975, 1976, 1977, 1978)

Injury Status	Fire/Explosion		Immersion		Total	
	Number	%	Number	%	Number	%
Not Injured	91	3.3	24	6.9	115	3.7
Killed	1825	66.6	268	77.5	2093	67.8
A	544	19.9	17	4.9	561	18.2
B	222	8.1	27	7.8	249	8.1
C	58	2.1	10	2.9	68	2.2
Unknown	1		1		2	
Total Occupants	2741	100	347	100	3088	100

3.2.3 Analysis of FARS Data

The analysis of a potential trapping effect for rear seat occupants in Post-Standard 2-door passenger cars was conducted for accidents involving post-crash fire or explosion and accidents involving immersion. The hypothesis tested in this particular analysis is that the presence of seat back locks increases the likelihood of rear seat occupants of Post-Standard 2-door cars being killed as a result of being trapped in a panic situation. Empirical measures of any potential trapping effect that might be attributed to the presence of seat back locks were obtained by contrasting the Pre- to Post-Standard ratios of occupant fatality rates for 2 and 4-door cars as follows.

$$\left[\begin{matrix}\text{Trapping}\\ \text{Effect}\\ (T)\end{matrix}\right] = \left[\left\{\frac{\text{Fatality Rate for Occupants of Post-Standard, 2-Door Cars}}{\text{Fatality Rate for Occupants of Pre-Standard, 2-Door Cars}} \times \frac{\text{Fatality Rate for Occupants of Pre-Standard, 4-Door Cars}}{\text{Fatality Rate for Occupants of Post-Standard, 4-Door Cars}}\right\} - 1\right] \times 100$$

where values of T are computed separately for front and rear seat occupants. Therefore, if the presence of seat back locks increases the possibility of rear seat occupants of 2-door cars being trapped, computed values of T for rear seat occupants will be positive, representing the precent increase in rear seat occupant fatality rates due, by inference, to trapping.

The distribution of fatalities among 3086 front seat occupants and 513 rear seat occupants in fire/explosion and immersion accidents is shown in Table 3-49 for 2-door and 4-door cars, Pre- and Post-Standard. The results of the trapping effect analysis are given in Table 3-50.

These results do not support the hypothesis that seat back locks may in-increase the possibility of rear seat occupants being trapped in panic situations. Contrary to expectations, a negative value of T (-19 percent) was computed for 513 rear seat occupants contrasted with a -4 percent value for front seat occupants. In other words, the data indicate that there is an estimated 19 percent decrease in the Pre- to Post-Standard ratios of rear seat occupant fatality rates corresponding to 2-door, Post-Standard vehicles. It can be speculated that the locked seat back may act as a restraint on the forward movement of rear seat passengers during a crash, and hence reduce the likelihood of serious or fatal injury. Such an effect is perhaps much more important than a possible trapping effect, and could be particularly important in more violent accidents involving fatalities and fire or explosion.

TABLE 3-49

FATALITY DISTRIBUTION IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

Front Seat Occupants

Injury Status	2-Door Cars				4-Door Cars				Total	
	Pre		Post		Pre		Post			
	No.	%	No.	%	No.	%	No.	%	No.	%
Killed	176	61.5	1316	68.5	122	58.4	456	68.2	2070	67.1
Not Killed	110	38.5	606	31.5	87	41.6	213	31.8	1016	32.9
Total Occupants	286	100	1922	100	209	100	669	100	3086	100

Rear Seat Occupants

Injury Status	2-Door Cars				4-Door Cars				Total	
	Pre		Post		Pre		Post			
	No.	%	No.	%	No.	%	No.	%	No.	%
Killed	20	51.3	150	45.3	10	37	47	40.5	227	44.2
Not Killed	19	48.7	181	54.7	17	63	69	59.5	286	55.8
Total Occupants	39	100	331	100	27	100	116	100	513	100

TABLE 3-50

DATA USED TO EVALUATE TRAPPING EFFECT

Condition	Occupant Location	Percent Killed in 2-Door Pre (P_{11})	Percent Killed in 2-Door Post (P_{21})	Percent Killed in 4-Door Pre (P_{12})	Percent Killed in 4-Door Post (P_{22})	Trapping Effect $T = \left[\left\{\frac{P_{12}}{P_{22}} \times \frac{P_{21}}{P_{11}}\right\} - 1\right] \times 100$	Standard Deviation
Fire/ Explosion/ Immersion	Rear Seat (N= 513)	51.3	45.3	37.0	40.5	- 19 Percent	27.3
	Front Seat (N=3086)	61.5	68.8	58.4	68.2	- 4 Percent	7.7

3.3 Analysis of NCSS Data on Seat Intrusion

3.3.1 Background

In an effort to obtain more information on seating system failure and associated injuries, available data from NCSS were examined. Unfortunately, the computerized information available is quite limited. Relevant information is contained in NCSS from 1 April 1978 onward regarding seat failure, although it is incomplete. A serious limitation to the data is that impact intrusion direction (forward or rearward) is not given when seat failure does not occur. It is given only for cases of seat failure. The variables of interest are:

- Pre/Post Standard
- 2-Door/4-Door Car
- Impact Intrusion Direction (Forward/Rearward)
- Seat Failure
  - No failure
  - Seat adjuster failure
  - Track failure
  - Seat back lock failure
  - Other failure
- AIS Injury Level

In the NCSS subsample studied here, the distribution of cases by seat failure is shown in Table 3-51. Less than four percent of the cases involved seat failure.

TABLE 3-51

DISTRIBUTION OF NCSS CASES BY SEAT FAILURE

Condition	Number of Cases	Percent
No Seat Failure	31,114	96.0
Seat Failure	1,226	3.8
Unknown	52	0.2
Total	32,392	100.0

3.3.2 Data Analysis

An initial review of the NCSS data produced the following ovservations and conclusions.

- The seat failure variable indicates there are 2383 Pre-Standard cases with seat failure occurring in 2.4 percent of the cases, as compared to 24,459 Post-Standard cases with seat failure occurring in 3.7 percent of them. Of course, seat failures involving the seat back lock are possible only in Post-Standard cars.

- It is not possible to analyze seating system failure/no failure as a function of impact intrusion direction because this variable is not reported in the case of no seat failure.
- The seat failure information is categorized as follows:

  a) Failure of seat adjuster.
  b) Failure of seat track.
  c) Failure of seat back locks.
  d) Other failures.

  Other failures generally refers to seat deformation resulting from passenger impact, inertial forces due to seat mass or deformation by intrusion of passenger compartment. Of the 961 cases of seat failure, 89 percent are in the "Other" category. Seat track failure and seat adjuster failure each account for 2-3 percent of the failure cases with seat back locks accounting for about 8 percent of the failure cases (i.e., 90 cases).

The distribution of AIS injury level by seat failure occurrence and non-occurrence is given in Table 3-52. The differences are very marked. There is no injury in 77 percent of the no seat failure cases in contrast to only 26 percent of the seat failure cases. A fatal or critical injury occurs in 2.9 percent of the seat failure cases in contrast to only 0.5 percent of the no seat failure cases. The limited sample size (only 32 cases) of known AIS level with seat back lock failure precludes estimating the AIS distribution separately for seat back lock failure (oddly, AIS level was unknown in 58 seat back lock failure cases).

TABLE 3-52

INJURY LEVEL DISTRIBUTION FOR SEAT FAILURE AND NO FAILURE

AIS Level	Seat Failure		No Seat Failure	
	Percent All	Percent (Unknowns Excluded)	Percent All	Percent (Unknowns Excluded)
0	17.7	(25.6)	56.5	(77.3)
1	27.5	(39.8)	12.0	(16.4)
2	10.4	(15.0)	2.8	(3.9)
3	8.8	(12.8)	1.1	(1.5)
4	2.7	(3.9)	0.3	(0.4)
5	1.4	(2.0)	0.3	(0.3)
6	0.7	(0.9)	0.1	(0.2)
Unknown	30.8	(--)	26.9	(--)
Total %	100.0	(100.0)	100.0	(100.0)
Total Cases	1226	(847)	31,114	(22,742)

The distribution of AIS injuries is given in Table 3-53 for rearward-directed forces and forward-directed forces in seat failure cases only. A forward-directed force is due to a rear impact and a rearward-directed force is due to a frontal impact. The distributions are fairly similar and it would be speculative to attempt to draw inferences from the small differences, given the limited number of cases upon which the distributions are based.

TABLE 3-53

INJURY LEVEL DISTRIBUTION BY INTRUSION FORCE DIRECTION FOR CASES OF SEAT FAILURE

AIS Level	Forward-Directed Force (%)	Rearward-Directed Force (%)
0	17.3	22.1
1	25.4	26.6
2	10.1	9.7
3	8.9	7.4
4	2.4	2.7
5	1.5	1.4
6	1.0	0.5
Unknown	33.4	29.6
Total %	100.0	100.0
Total Cases	682	444

The distribution of seat failure type by rearward-directed and forward-directed forces is given in Table 3-54. Of greatest interest in the comparative distributions is the greater frequency of occurrence of seat back lock failure with a rearward-directed force (i.e., a force due to a frontal impact).

TABLE 3-54

FREQUENCY OF SEAT FAILURE BY INTRUSION FORCE DIRECTION

Seat Failure Type	Forward-Directed Force (%)	Rearward-Directed Force (%)
Seat Adjuster	2.8	2.0
Track	3.4	2.5
Lock	5.4	11.9
Other	85.2	77.3
Unknown	3.2	6.3
Total %	100.0	100.0
Total Cases	682	444

In summary, the NCSS data sample contains limited computerized information on seat failure and injury for cases after April 1, 1978. Seat failure occurred in 2.4 percent of 2,383 Pre-Standard cases as compared with 3.7 percent of 24,459 Post-Standard cases. Only 90 cases of seat back lock failure are available and the AIS level is unknown for 58 of these cases. Based on 847 cases of all types of seat failure and 22,742 cases without failure with known AIS, the probability of escaping any injury is three times greater when no seat failure occurs, and the probability of a fatal or critical injury is about five times greater with seat failure. Seat failure/no failure comparisons are restricted by the lack of information on impact intrusion direction (forward or rearward) for no failure cases.

3.4 References for Section 3

1. Motor Vehicle Manufacturers Association of the U.S., Inc. *Automotive Facts and Figures*, 1967-1973, MVMA, Detroit, Michigan.

2. Engleman, L., J.W. Frane and R.I. Jennrich. *BMDP-77 Biomedical Computer Programs P-Series*, University of California Press, Berkeley, California, 1977.

3. Clark, V.J. *Single Variable Tabulations for 1973-1976 North Carolina Accidents*, Highway Safety Research Center, University of North Carolina, Chapel Hill, North Carolina, 1977.

APPENDIX A

FULLY CROSS CLASSIFIED TABLES

OF OBSERVED STATE MASS ACCIDENT DATA

TABLE A-1

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1972
RAW DATA FOR KA/BCO INJURY DICHOTOMY

City Size: Less than 5,000						City Size: 5,000-250,000					
DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	I I	INJURY (I) K+A	B+C+O	DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	I I	INJURY (I) K+A	B+C+O
15-24	OTHER MV	2-DOOR	PRE	I	74	1461	15-24	OTHER MV	2-DOOR	PRE	I	69	5473
			POST	I	129	2610				POST	I	63	8995
				I							I		
		4-DOOR	PRE	I	83	1484			4-DOOR	PRE	I	45	5297
			POST	I	35	923				POST	I	16	2880
				I-----		-----					I-----		-----
	PARKED CAR	2-DOOR	PRE	I	3	90		PARKED CAR	2-DOOR	PRE	I	10	481
			POST	I	5	83				POST	I	4	494
				I							I		
		4-DOOR	PRE	I	2	109			4-DOOR	PRE	I	9	550
			POST	I	0	32				POST	I	5	215
				I-----		-----					I-----		-----
	OBJECT	2-DOOR	PRE	I	42	274		OBJECT	2-DOOR	PRE	I	48	596
			POST	I	48	497				POST	I	56	872
				I							I		
		4-DOOR	PRE	I	32	239			4-DOOR	PRE	I	35	591
			POST	I	19	118				POST	I	9	230
				I-----		-----					I-----		-----
25-34	OTHER MV	2-DOOR	PRE	I	42	544	25-34	OTHER MV	2-DOOR	PRE	I	25	1927
			POST	I	64	1355				POST	I	38	4365
				I							I		
		4-DOOR	PRE	I	43	643			4-DOOR	PRE	I	36	2094
			POST	I	44	750				POST	I	15	2010
				I-----		-----					I-----		-----
	PARKED CAR	2-DOOR	PRE	I	4	29		PARKED CAR	2-DOOR	PRE	I	5	135
			POST	I	5	28				POST	I	2	173
				I							I		
		4-DOOR	PRE	I	0	37			4-DOOR	PRE	I	3	173
			POST	I	0	21				POST	I	1	94
				I-----		-----					I-----		-----
	OBJECT	2-DOOR	PRE	I	17	84		OBJECT	2-DOOR	PRE	I	13	189
			POST	I	19	216				POST	I	24	358
				I							I		
		4-DOOR	PRE	I	17	88			4-DOOR	PRE	I	16	216
			POST	I	5	95				POST	I	6	115
				I-----		-----					I-----		-----
35 +	OTHER MV	2-DOOR	PRE	I	69	754	35 +	OTHER MV	2-DOOR	PRE	I	41	2476
			POST	I	83	1439				POST	I	35	4187
				I							I		
		4-DOOR	PRE	I	137	1938			4-DOOR	PRE	I	85	6038
			POST	I	176	2663				POST	I	76	7089
				I-----		-----					I-----		-----
	PARKED CAR	2-DOOR	PRE	I	1	29		PARKED CAR	2-DOOR	PRE	I	9	193
			POST	I	1	32				POST	I	8	194
				I							I		
		4-DOOR	PRE	I	4	99			4-DOOR	PRE	I	15	578
			POST	I	5	58				POST	I	2	294
				I-----		-----					I-----		-----
	OBJECT	2-DOOR	PRE	I	25	112		OBJECT	2-DOOR	PRE	I	21	175
			POST	I	19	169				POST	I	31	259
				I							I		
		4-DOOR	PRE	I	42	219			4-DOOR	PRE	I	45	414
			POST	I	32	269				POST	I	15	359

TABLE A-1 (Continued)

City Size: Over 250,000

DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	I I	INJURY (I) K+A	B+C+O
15-24	OTHER MV	2-DOOR	PRE	I	118	5854
			POST	I	139	10647
		4-DOOR	PRE	I	77	5032
			POST	I	25	2790
	PRKD CAR	2-DOOR	PRE	I	11	451
			POST	I	13	505
		4-DOOR	PRE	I	8	458
			POST	I	2	139
	OBJECT	2-DOOR	PRE	I	89	684
			POST	I	59	982
		4-DOOR	PRE	I	86	556
			POST	I	20	213
25-34	OTHER MV	2-DOOR	PRE	I	67	3179
			POST	I	100	7647
		4-DOOR	PRE	I	64	2809
			POST	I	19	2833
	PRKD CAR	2-DOOR	PRE	I	14	212
			POST	I	11	253
		4-DOOR	PRE	I	11	242
			POST	I	2	83
	OBJECT	2-DOOR	PRE	I	49	277
			POST	I	50	531
		4-DOOR	PRE	I	48	256
			POST	I	21	150
35 +	OTHER MV	2-DOOR	PRE	I	79	3794
			POST	I	78	6940
		4-DOOR	PRE	I	129	6533
			POST	I	88	8513
	PRKD CAR	2-DOOR	PRE	I	10	288
			POST	I	10	297
		4-DOOR	PRE	I	24	494
			POST	I	9	280
	OBJECT	2-DOOR	PRE	I	43	244
			POST	I	39	389
		4-DOOR	PRE	I	69	471
			POST	I	42	338

THE TOTAL FREQUENCY IS 159693

TABLR A-2

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1972
RAW DATA FOR KAB/CO INJURY DICHOTOMY

City Size: Less than 5,000						City Size: 5,000-250,000					
DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	I	INJURY (I) K+A+B	C+O	DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	I	INJURY (I) K+A+B	C+O
15-24	OTHER MV	2-DOOR	PRE	I	198	1337	15-24	OTHER MV	2-DOOR	PRE	I	326	5216
			POST	I	355	2384				POST	I	382	8676
				I							I		
		4-DOOR	PRE	I	211	1356			4-DOOR	PRE	I	259	5083
			POST	I	88	870				POST	I	113	2783
				I							I		
	PRKD CAR	2-DOOR	PRE	I	12	81		PRKD CAR	2-DOOR	PRE	I	57	434
			POST	I	9	79				POST	I	42	456
				I							I		
		4-DOOR	PRE	I	9	102			4-DOOR	PRE	I	57	482
			POST	I	2	30				POST	I	16	204
				I							I		
	OBJECT	2-DOOR	PRE	I	81	235		OBJECT	2-DOOR	PRE	I	152	492
			POST	I	121	424				POST	I	195	733
				I							I		
		4-DOOR	PRE	I	81	190			4-DOOR	PRE	I	135	491
			POST	I	35	102				POST	I	47	192
				I							I		
25-34	OTHER MV	2-DOOR	PRE	I	85	501	25-34	OTHER MV	2-DOOR	PRE	I	143	1809
			POST	I	175	1244				POST	I	199	4204
				I							I		
		4-DOOR	PRE	I	101	585			4-DOOR	PRE	I	139	1991
			POST	I	99	695				POST	I	87	1938
				I							I		
	PRKD CAR	2-DOOR	PRE	I	8	25		PRKD CAR	2-DOOR	PRE	I	24	116
			POST	I	6	25				POST	I	21	154
				I							I		
		4-DOOR	PRE	I	6	31			4-DOOR	PRE	I	17	159
			POST	I	5	16				POST	I	4	86
				I							I		
	OBJECT	2-DOOR	PRE	I	32	69		OBJECT	2-DOOR	PRE	I	58	144
			POST	I	51	184				POST	I	80	302
				I							I		
		4-DOOR	PRE	I	33	72			4-DOOR	PRE	I	53	179
			POST	I	20	80				POST	I	23	98
				I							I		
35 +	OTHER MV	2-DOOR	PRE	I	135	688	35 +	OTHER MV	2-DOOR	PRE	I	167	2350
			POST	I	215	1307				POST	I	207	4015
				I							I		
		4-DOOR	PRE	I	357	1718			4-DOOR	PRE	I	366	5757
			POST	I	413	2426				POST	I	319	6846
				I							I		
	PRKD CAR	2-DOOR	PRE	I	7	23		PRKD CAR	2-DOOR	PRE	I	28	174
			POST	I	9	24				POST	I	34	168
				I							I		
		4-DOOR	PRE	I	15	88			4-DOOR	PRE	I	58	535
			POST	I	10	51				POST	I	22	274
				I							I		
	OBJECT	2-DOOR	PRE	I	36	99		OBJECT	2-DOOR	PRE	I	59	137
			POST	I	42	146				POST	I	76	214
				I							I		
		4-DOOR	PRE	I	86	175			4-DOOR	PRE	I	143	316
			POST	I	68	253				POST	I	90	284

TABLE A-2 (Continued)

City Size: Over 250,000

DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
15-24	OTHER MV	2-DOOR	PRE	399	5573
			POST	514	10272
		4-DOOR	PRE	263	4846
			POST	87	2728
	PRKD CAR	2-DOOR	PRE	61	401
			POST	64	454
		4-DOOR	PRE	56	410
			POST	12	129
	OBJECT	2-DOOR	PRE	222	551
			POST	228	813
		4-DOOR	PRE	190	452
			POST	59	174
25-34	OTHER MV	2-DOOR	PRE	209	3037
			POST	319	7428
		4-DOOR	PRE	182	2691
			POST	93	2759
	PRKD CAR	2-DOOR	PRE	30	196
			POST	35	229
		4-DOOR	PRE	43	210
			POST	12	73
	OBJECT	2-DOOR	PRE	109	217
			POST	137	444
		4-DOOR	PRE	106	198
			POST	56	115
35 +	OTHER MV	2-DOOR	PRE	294	3579
			POST	314	6704
		4-DOOR	PRE	381	6281
			POST	296	8305
	PRKD CAR	2-DOOR	PRE	47	251
			POST	42	265
		4-DOOR	PRE	83	435
			POST	40	249
	OBJECT	2-DOOR	PRE	97	190
			POST	113	315
		4-DOOR	PRE	166	374
			POST	99	281

THE TOTAL FREQUENCY IS 159693

TABLE A-3

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1972
RAW DATA FOR KABC/O INJURY DICHOTOMY

City Size: Less than 5,000							City Size: 5,000-250,000						
DRVAGE D	ACCTYPE A	STYLE S	PRE/POST P	I	INJURY (I) K+A+B+C	O	DRVAGE D	ACCTYPE A	STYLE S	PRE/POST P	I	INJURY (I) K+A+B+C	O
15-24	OTHER MV	2-DOOR	PRE	I	262	1273	15-24	OTHER MV	2-DOOR	PRE	I	495	5047
			POST	I	446	2293				POST	I	639	8419
		4-DOOR	PRE	I	264	1303			4-DOOR	PRE	I	400	4942
			POST	I	130	828				POST	I	180	2716
	PKUP CAR	2-DOOR	PRE	I	17	76		PKUP CAR	2-DOOR	PRE	I	71	420
			POST	I	11	77				POST	I	68	430
		4-DOOR	PRE	I	11	100			4-DOOR	PRE	I	68	471
			POST	I	5	27				POST	I	29	191
	OBJECT	2-DOOR	PRE	I	94	222		OBJECT	2-DOOR	PRE	I	195	449
			POST	I	143	402				POST	I	256	672
		4-DOOR	PRE	I	97	174			4-DOOR	PRE	I	174	452
			POST	I	41	96				POST	I	64	175
25-34	OTHER MV	2-DOOR	PRE	I	107	479	25-34	OTHER MV	2-DOOR	PRE	I	231	1721
			POST	I	232	1187				POST	I	326	4077
		4-DOOR	PRE	I	132	554			4-DOOR	PRE	I	211	1919
			POST	I	142	652				POST	I	145	1880
	PKUP CAR	2-DOOR	PRE	I	8	25		PKUP CAR	2-DOOR	PRE	I	31	109
			POST	I	8	23				POST	I	27	148
		4-DOOR	PRE	I	7	30			4-DOOR	PRE	I	21	155
			POST	I	5	16				POST	I	13	82
	OBJECT	2-DOOR	PRE	I	37	64		OBJECT	2-DOOR	PRE	I	70	132
			POST	I	63	172				POST	I	97	289
		4-DOOR	PRE	I	38	67			4-DOOR	PRE	I	70	162
			POST	I	23	77				POST	I	28	93
35 +	OTHER MV	2-DOOR	PRE	I	164	659	35 +	OTHER MV	2-DOOR	PRE	I	254	2263
			POST	I	275	1247				POST	I	360	3862
		4-DOOR	PRE	I	437	1638			4-DOOR	PRE	I	585	5538
			POST	I	516	2323				POST	I	535	6630
	PKUP CAR	2-DOOR	PRE	I	8	22		PKUP CAR	2-DOOR	PRE	I	37	165
			POST	I	9	24				POST	I	40	162
		4-DOOR	PRE	I	20	83			4-DOOR	PRE	I	74	519
			POST	I	14	47				POST	I	37	259
	OBJECT	2-DOOR	PRE	I	46	69		OBJECT	2-DOOR	PRE	I	66	130
			POST	I	54	134				POST	I	90	200
		4-DOOR	PRE	I	102	159			4-DOOR	PRE	I	174	285
			POST	I	93	208				POST	I	104	270

TABLE A-3 (Continued)

City Size: Over 250,000

DRVAGE D	ACCTYPE A	STYLE S	PRE/POST P	I I	INJURY (I) K+A+B+C	D
15-24	OTHER MV	2-DOOR	PRE	I	603	5369
			POST	I	844	9942
				I		
		4-DOOR	PRE	I	403	4706
			POST	I	156	2659
				I		
	PKED CAR	2-DOOR	PRE	I	81	581
			POST	I	85	433
				I		
		4-DOOR	PRE	I	71	395
			POST	I	16	125
				I		
	OBJECT	2-DOOR	PRE	I	264	509
			POST	I	300	741
				I		
		4-DOOR	PRE	I	209	433
			POST	I	74	159
				I		
25-34	OTHER MV	2-DOOR	PRE	I	536	2910
			POST	I	570	7177
				I		
		4-DOOR	PRE	I	297	2576
			POST	I	194	2658
				I		
	PKED CAR	2-DOOR	PRE	I	42	184
			POST	I	44	220
				I		
		4-DOOR	PRE	I	54	199
			POST	I	15	70
				I		
	OBJECT	2-DOOR	PRE	I	122	204
			POST	I	180	401
				I		
		4-DOOR	PRE	I	121	183
			POST	I	65	106
				I		
35 +	OTHER MV	2-DOOR	PRE	I	445	3428
			POST	I	559	6459
				I		
		4-DOOR	PRE	I	603	6059
			POST	I	511	8090
				I		
	PKED CAR	2-DOOR	PRE	I	55	243
			POST	I	52	255
				I		
		4-DOOR	PRE	I	101	417
			POST	I	53	236
				I		
	OBJECT	2-DOOR	PRE	I	115	172
			POST	I	150	278
				I		
		4-DOOR	PRE	I	191	349
			POST	I	117	263

THE TOTAL FREQUENCY IS 159693

TABLE A-4

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1973
RAW DATA FOR KA/BCO INJURY DICHOTOMY

Driver Age: 15-24							Driver Age: 25-34						
ROCLASS R	CITYSIZE C	STYLE S	PRE|POST P	I	INJURY (I) K+A	B+C+O	ROCLASS R	CITYSIZE C	STYLE S	PRE|POST P	I	INJURY (I) K+A	B+C+O
HIGHWAY	LT 50K	2-DOOR	PRE	I	59	706	HIGHWAY	LT 50K	2-DOOR	PRE	I	45	294
			POST	I	165	2122				POST	I	75	1060
				I							I		
		4-DOOR	PRE	I	65	687			4-DOOR	PRE	I	30	288
			POST	I	47	727				POST	I	34	530
				I							I		
	50K-250K	2-DOOR	PRE	I	36	1859		50K-250K	2-DOOR	PRE	I	18	719
			POST	I	73	4809				POST	I	37	2291
				I							I		
		4-DOOR	PRE	I	50	1770			4-DOOR	PRE	I	24	803
			POST	I	14	1534				POST	I	13	1058
				I							I		
	250K +	2-DOOR	PRE	I	48	1808		250K +	2-DOOR	PRE	I	30	1004
			POST	I	91	5348				POST	I	71	3897
				I							I		
		4-DOOR	PRE	I	38	1572			4-DOOR	PRE	I	21	963
			POST	I	17	1380				POST	I	19	1346
				I							I		
CNTY RD	LT 50K	2-DOOR	PRE	I	28	467	CNTY RD	LT 50K	2-DOOR	PRE	I	16	168
			POST	I	61	1137				POST	I	28	533
				I							I		
		4-DOOR	PRE	I	29	477			4-DOOR	PRE	I	17	190
			POST	I	17	360				POST	I	14	284
				I							I		
	50K-250K	2-DOOR	PRE	I	9	266		50K-250K	2-DOOR	PRE	I	2	81
			POST	I	13	662				POST	I	7	274
				I							I		
		4-DOOR	PRE	I	2	237			4-DOOR	PRE	I	5	87
			POST	I	1	210				POST	I	4	101
				I							I		
	250K +	2-DOOR	PRE	I	5	83		250K +	2-DOOR	PRE	I	2	44
			POST	I	1	278				POST	I	6	200
				I							I		
		4-DOOR	PRE	I	1	69			4-DOOR	PRE	I	0	55
			POST	I	1	63				POST	I	0	57
				I							I		
CITY STR	LT 50K	2-DOOR	PRE	I	8	269	CITY STR	LT 50K	2-DOOR	PRE	I	0	62
			POST	I	8	514				POST	I	6	210
				I							I		
		4-DOOR	PRE	I	2	301			4-DOOR	PRE	I	1	73
			POST	I	3	260				POST	I	2	117
				I							I		
	50K-250K	2-DOOR	PRE	I	59	3349		50K-250K	2-DOOR	PRE	I	22	1043
			POST	I	78	7158				POST	I	32	3171
				I							I		
		4-DOOR	PRE	I	47	3388			4-DOOR	PRE	I	31	1173
			POST	I	11	2481				POST	I	12	1482
				I							I		
	250K +	2-DOOR	PRE	I	100	3863		250K +	2-DOOR	PRE	I	46	1892
			POST	I	154	8857				POST	I	96	6036
				I							I		
		4-DOOR	PRE	I	94	3364			4-DOOR	PRE	I	48	1774
			POST	I	36	2727				POST	I	24	2154

TABLE A-4 (Continued)

Driver Age: 35 and Older

ROCLASS R	CITYSIZE C	STYLE S	PREPOST P	I I	INJURY (I) K+A	B+C+O
HIGHWAY	LT 50K	2-DOOR	PRE	I	48	424
			POST	I	82	1119
				I		
		4-DOOR	PRE	I	111	1094
			POST	I	176	2077
	50K-250K	2-DOOR	PRE	I	22	836
			POST	I	36	2185
				I		
		4-DOOR	PRE	I	53	2095
			POST	I	49	3653
	250K +	2-DOOR	PRE	I	48	1101
			POST	I	68	3285
				I		
		4-DOOR	PRE	I	52	1832
			POST	I	46	3599
CNTY RD	LT 50K	2-DOOR	PRE	I	14	204
			POST	I	31	531
				I		
		4-DOOR	PRE	I	40	452
			POST	I	54	814
	50K-250K	2-DOOR	PRE	I	7	92
			POST	I	2	220
				I		
		4-DOOR	PRE	I	3	192
			POST	I	9	389
	250K +	2-DOOR	PRE	I	1	47
			POST	I	1	175
				I		
		4-DOOR	PRE	I	0	79
			POST	I	4	168
CITY STR	LT 50K	2-DOOR	PRE	I	1	122
			POST	I	1	222
				I		
		4-DOOR	PRE	I	5	301
			POST	I	5	405
	50K-250K	2-DOOR	PRE	I	22	1329
			POST	I	27	2987
				I		
		4-DOOR	PRE	I	55	3127
			POST	I	43	4648
	250K +	2-DOOR	PRE	I	60	2180
			POST	I	61	5464
				I		
		4-DOOR	PRE	I	97	3938
			POST	I	68	6159

THE TOTAL FREQUENCY IS 161908

TABLE A-5

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1973
RAW DATA FOR KAB/CO INJURY DICHOTOMY

Driver Age: 15-24						Driver Age: 25-34					
RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	I	INJURY (I) K+A+B	C+O	RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	I	INJURY (I) K+A+B	C+O
HIGHWAY	LT 50K	2-DOOR	PRE	I	134	651	HIGHWAY	LT 50K	2-DOOR	PRE	I	75	254
			POST	I	391	1896				POST	I	176	959
		4-DOOR	PRE	I	155	619			4-DOOR	PRE	I	67	251
			POST	I	116	658				POST	I	86	478
	50K-250K	2-DOOR	PRE	I	167	1728		50K-250K	2-DOOR	PRE	I	76	659
			POST	I	342	4550				POST	I	164	2164
		4-DOOR	PRE	I	158	1642			4-DOOR	PRE	I	86	741
			POST	I	77	1471				POST	I	77	994
	250K +	2-DOOR	PRE	I	180	1676		250K +	2-DOOR	PRE	I	98	936
			POST	I	375	5064				POST	I	248	3720
		4-DOOR	PRE	I	127	1483			4-DOOR	PRE	I	80	904
			POST	I	70	1327				POST	I	85	1280
CNTY RD	LT 50K	2-DOOR	PRE	I	70	425	CNTY RD	LT 50K	2-DOOR	PRE	I	39	145
			POST	I	161	1037				POST	I	71	490
		4-DOOR	PRE	I	76	430			4-DOOR	PRE	I	45	164
			POST	I	47	350				POST	I	38	260
	50K-250K	2-DOOR	PRE	I	32	243		50K-250K	2-DOOR	PRE	I	4	79
			POST	I	56	619				POST	I	22	259
		4-DOOR	PRE	I	21	218			4-DOOR	PRE	I	10	82
			POST	I	11	200				POST	I	12	93
	250K +	2-DOOR	PRE	I	9	77		250K +	2-DOOR	PRE	I	9	37
			POST	I	14	265				POST	I	15	193
		4-DOOR	PRE	I	2	68			4-DOOR	PRE	I	7	48
			POST	I	3	61				POST	I	3	54
CITY STR	LT 50K	2-DOOR	PRE	I	23	254	CITY STR	LT 50K	2-DOOR	PRE	I	6	56
			POST	I	56	486				POST	I	15	201
		4-DOOR	PRE	I	18	285			4-DOOR	PRE	I	11	63
			POST	I	12	251				POST	I	8	111
	50K-250K	2-DOOR	PRE	I	289	3119		50K-250K	2-DOOR	PRE	I	79	986
			POST	I	469	6767				POST	I	163	3040
		4-DOOR	PRE	I	247	3188			4-DOOR	PRE	I	117	1087
			POST	I	114	2378				POST	I	50	1444
	250K +	2-DOOR	PRE	I	371	3592		250K +	2-DOOR	PRE	I	172	1766
			POST	I	585	8428				POST	I	337	5795
		4-DOOR	PRE	I	297	3161			4-DOOR	PRE	I	162	1660
			POST	I	151	2612				POST	I	101	2077

TABLE A-5 (Continued)

Driver Age: 35 and Older

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
HIGHWAY	LT 50K	2-DOOR	PRE	101	361
			POST	201	1000
		4-DOOR	PRE	222	983
			POST	369	1884
	50K-250K	2-DOOR	PRE	92	766
			POST	150	2071
		4-DOOR	PRE	182	1966
			POST	227	3475
	250K +	2-DOOR	PRE	134	1015
			POST	234	3119
		4-DOOR	PRE	181	1703
			POST	182	3463
CNTY RD	LT 50K	2-DOOR	PRE	36	182
			POST	77	485
		4-DOOR	PRE	83	409
			POST	124	744
	50K-250K	2-DOOR	PRE	20	79
			POST	22	200
		4-DOOR	PRE	16	179
			POST	30	368
	250K +	2-DOOR	PRE	5	43
			POST	7	169
		4-DOOR	PRE	7	72
			POST	11	161
CITY STR	LT 50K	2-DOOR	PRE	13	110
			POST	14	209
		4-DOOR	PRE	14	290
			POST	25	385
	50K-250K	2-DOOR	PRE	133	1218
			POST	158	2856
		4-DOOR	PRE	207	2975
			POST	225	4466
	250K +	2-DOOR	PRE	213	2027
			POST	301	5224
		4-DOOR	PRE	328	3707
			POST	301	5926

THE TOTAL FREQUENCY IS 161908

TABLE A-6

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1973
RAW DATA FOR KABC/O INJURY DICHOTOMY

Driver Age: 15-24						Driver Age: 25-34					
ROCLASS R	CITYSIZE C	STYLE S	PREPOST P	I I	INJURY (I) K+A+B+C	O	ROCLASS R	CITYSIZE C	STYLE S	PREPOST P	I I	INJURY (I) K+A+B+C	O
HIGHWAY	LT 50K	2-DOOR	PRE	I	164	601	HIGHWAY	LT 50K	2-DOOR	PRE	I	92	237
			POST	I	484	1803				POST	I	225	910
				I							I		
		4-DOOR	PRE	I	161	591			4-DOOR	PRE	I	81	237
			POST	I	148	626				POST	I	115	451
				I-----							I-----		
	50K-250K	2-DOOR	PRE	I	245	1650		50K-250K	2-DOOR	PRE	I	98	639
			POST	I	506	4376				POST	I	245	2083
				I							I		
		4-DOOR	PRE	I	205	1595			4-DOOR	PRE	I	114	713
			POST	I	122	1426				POST	I	112	959
				I-----							I-----		
	250K +	2-DOOR	PRE	I	250	1606		250K +	2-DOOR	PRE	I	145	889
			POST	I	561	4878				POST	I	385	3583
				I							I		
		4-DOOR	PRE	I	183	1427			4-DOOR	PRE	I	121	863
			POST	I	118	1279				POST	I	137	1228
				I-----							I-----		
CNTY RD	LT 50K	2-DOOR	PRE	I	84	411	CNTY RD	LT 50K	2-DOOR	PRE	I	46	138
			POST	I	211	987				POST	I	98	463
				I							I		
		4-DOOR	PRE	I	91	415			4-DOOR	PRE	I	49	158
			POST	I	64	333				POST	I	46	252
				I-----							I-----		
	50K-250K	2-DOOR	PRE	I	37	238		50K-250K	2-DOOR	PRE	I	7	76
			POST	I	78	597				POST	I	29	252
				I							I		
		4-DOOR	PRE	I	28	211			4-DOOR	PRE	I	11	81
			POST	I	14	197				POST	I	16	89
				I-----							I-----		
	250K +	2-DOOR	PRE	I	18	68		250K +	2-DOOR	PRE	I	11	35
			POST	I	24	255				POST	I	24	182
				I							I		
		4-DOOR	PRE	I	5	65			4-DOOR	PRE	I	9	46
			POST	I	3	61				POST	I	9	48
				I-----							I-----		
CITY STR	LT 50K	2-DOOR	PRE	I	30	247	CITY STR	LT 50K	2-DOOR	PRE	I	7	55
			POST	I	57	465				POST	I	21	195
				I							I		
		4-DOOR	PRE	I	24	279			4-DOOR	PRE	I	13	61
			POST	I	18	245				POST	I	14	105
				I-----							I-----		
	50K-250K	2-DOOR	PRE	I	413	2995		50K-250K	2-DOOR	PRE	I	123	942
			POST	I	658	6578				POST	I	277	2926
				I							I		
		4-DOOR	PRE	I	358	3077			4-DOOR	PRE	I	158	1046
			POST	I	177	2315				POST	I	100	1394
				I-----							I-----		
	250K +	2-DOOR	PRE	I	547	3416		250K +	2-DOOR	PRE	I	245	1693
			POST	I	900	8111				POST	I	551	5581
				I							I		
		4-DOOR	PRE	I	425	3034			4-DOOR	PRE	I	234	1588
			POST	I	252	2511				POST	I	177	2001

TABLE A-6 (Continued)

Driver Age: 35 and Older						
RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	I I	INJURY (I) K+A+B+C	O
HIGHWAY	LT 50K	2-DOOR	PRE	I	124	338
			POST	I	260	941
		4-DOOR	PRE	I	269	936
			POST	I	469	1784
	50K-250K	2-DOOR	PRE	I	113	745
			POST	I	226	1995
		4-DOOR	PRE	I	247	1901
			POST	I	352	3350
	250K +	2-DOOR	PRE	I	175	974
			POST	I	370	2983
		4-DOOR	PRE	I	253	1631
			POST	I	290	3355
CNTY RD	LT 50K	2-DOOR	PRE	I	45	173
			POST	I	104	458
		4-DOOR	PRE	I	103	389
			POST	I	161	707
	50K-250K	2-DOOR	PRE	I	22	77
			POST	I	37	185
		4-DOOR	PRE	I	19	176
			POST	I	40	358
	250K +	2-DOOR	PRE	I	6	42
			POST	I	13	163
		4-DOOR	PRE	I	9	70
			POST	I	16	156
CITY STR	LT 50K	2-DOOR	PRE	I	18	105
			POST	I	20	203
		4-DOOR	PRE	I	23	281
			POST	I	40	370
	50K-250K	2-DOOR	PRE	I	173	1178
			POST	I	280	2734
		4-DOOR	PRE	I	314	2868
			POST	I	385	4306
	250K +	2-DOOR	PRE	I	295	1945
			POST	I	522	5003
		4-DOOR	PRE	I	466	3569
			POST	I	518	5709

THE TOTAL FREQUENCY IS 161908

TABLE A-7

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1974
RAW DATA FOR KA/BCO INJURY DICHOTOMY

TAD: 1-2						TAD: 3-4					
ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I I	INJURY (I) K+A	B+C+O	ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I I	INJURY (I) K+A	B+C+O
OTHER MV	LT 50K	2-DOOR	PRE	I	1	757	OTHER MV	LT 50K	2-DOOR	PRE	I	15	560
			POST	I	4	2902				POST	I	44	2199
				I							I		
		4-DOOR	PRE	I	4	1177			4-DOOR	PRE	I	32	833
			POST	I	2	2306				POST	I	25	1539
				I----------							I----------		
	50K-250K	2-DOOR	PRE	I	1	3997		50K-250K	2-DOOR	PRE	I	39	1594
			POST	I	12	14470				POST	I	63	5710
				I							I		
		4-DOOR	PRE	I	2	5708			4-DOOR	PRE	I	47	2005
			POST	I	2	9641				POST	I	26	3338
				I----------							I----------		
	250K +	2-DOOR	PRE	I	18	5302		250K +	2-DOOR	PRE	I	80	1998
			POST	I	32	22178				POST	I	173	8030
				I							I		
		4-DOOR	PRE	I	11	6171			4-DOOR	PRE	I	74	2156
			POST	I	16	11952				POST	I	71	3603
				I----------							I----------		
PKUP CAR	LT 50K	2-DOOR	PRE	I	0	50	PKUP CAR	LT 50K	2-DOOR	PRE	I	3	45
			POST	I	1	96				POST	I	5	127
				I							I		
		4-DOOR	PRE	I	0	59			4-DOOR	PRE	I	2	53
			POST	I	0	91				POST	I	4	66
				I----------							I----------		
	50K-250K	2-DOOR	PRE	I	0	295		50K-250K	2-DOOR	PRE	I	10	234
			POST	I	1	637				POST	I	11	573
				I							I		
		4-DOOR	PRE	I	1	504			4-DOOR	PRE	I	9	339
			POST	I	0	409				POST	I	6	400
				I----------							I----------		
	250K +	2-DOOR	PRE	I	0	289		250K +	2-DOOR	PRE	I	16	280
			POST	I	5	681				POST	I	17	663
				I							I		
		4-DOOR	PRE	I	3	421			4-DOOR	PRE	I	17	302
			POST	I	6	368				POST	I	16	333
				I----------							I----------		
OBJECT	LT 50K	2-DOOR	PRE	I	4	105	OBJECT	LT 50K	2-DOOR	PRE	I	7	102
			POST	I	5	375				POST	I	23	468
				I							I		
		4-DOOR	PRE	I	2	127			4-DOOR	PRE	I	15	151
			POST	I	3	227				POST	I	9	229
				I----------							I----------		
	50K-250K	2-DOOR	PRE	I	2	301		50K-250K	2-DOOR	PRE	I	15	300
			POST	I	3	829				POST	I	39	904
				I							I		
		4-DOOR	PRE	I	0	375			4-DOOR	PRE	I	29	353
			POST	I	2	385				POST	I	27	391
				I----------							I----------		
	250K +	2-DOOR	PRE	I	6	339		250K +	2-DOOR	PRE	I	47	453
			POST	I	10	915				POST	I	101	1203
				I							I		
		4-DOOR	PRE	I	4	351			4-DOOR	PRE	I	56	432
			POST	I	5	387				POST	I	42	487

TABLE A-7 (Continued)

TAD: 5-7

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I	INJURY (I) K+A	B+C+D
OTHER MV	LT 50K	2-DOOR	PRE	I	69	129
			POST	I	215	552
		4-DOOR	PRE	I	90	142
			POST	I	144	369
	50K-250K	2-DOOR	PRE	I	33	185
			POST	I	91	748
		4-DOOR	PRE	I	56	228
			POST	I	38	373
	250K +	2-DOOR	PRE	I	43	173
			POST	I	85	682
		4-DOOR	PRE	I	38	163
			POST	I	34	248
PKAD CAR	LT 50K	2-DOOR	PRE	I	3	11
			POST	I	12	36
		4-DOOR	PRE	I	6	10
			POST	I	3	16
	50K-250K	2-DOOR	PRE	I	6	19
			POST	I	15	119
		4-DOOR	PRE	I	8	46
			POST	I	8	65
	250K +	2-DOOR	PRE	I	2	30
			POST	I	15	92
		4-DOOR	PRE	I	5	38
			POST	I	5	35
OBJECT	LT 50K	2-DOOR	PRE	I	16	35
			POST	I	65	156
		4-DOOR	PRE	I	25	45
			POST	I	43	70
	50K-250K	2-DOOR	PRE	I	30	81
			POST	I	56	279
		4-DOOR	PRE	I	36	91
			POST	I	29	116
	250K +	2-DOOR	PRE	I	49	93
			POST	I	82	300
		4-DOOR	PRE	I	27	77
			POST	I	27	92

THE TOTAL FREQUENCY IS 146449

TABLE A-8

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1974
RAW DATA FOR KAB/CO INJURY DICHOTOMY

TAD: 1-2						TAD: 3-4					
ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I	INJURY (I) K+A+B	C+O	ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I	INJURY (I) K+A+B	C+O
OTHER MV	LT 50K	2-DOOR	PRE	I	13	745	OTHER MV	LT 50K	2-DOOR	PRE	I	87	488
			POST	I	36	2870				POST	I	278	1965
				I							I		
		4-DOOR	PRE	I	19	1162			4-DOOR	PRE	I	150	715
			POST	I	23	2285				POST	I	179	1385
				I							I		
	50K-250K	2-DOOR	PRE	I	46	3952		50K-250K	2-DOOR	PRE	I	217	1416
			POST	I	135	14347				POST	I	550	5223
				I							I		
		4-DOOR	PRE	I	82	5628			4-DOOR	PRE	I	297	1755
			POST	I	68	9575				POST	I	266	3098
				I							I		
	250K +	2-DOOR	PRE	I	104	5216		250K +	2-DOOR	PRE	I	316	1762
			POST	I	234	21976				POST	I	842	7361
				I							I		
		4-DOOR	PRE	I	113	6069			4-DOOR	PRE	I	322	1908
			POST	I	88	11880				POST	I	346	3328
				I							I		
PKUP CAR	LT 50K	2-DOOR	PRE	I	3	47	PKUP CAR	LT 50K	2-DOOR	PRE	I	11	37
			POST	I	3	94				POST	I	13	119
				I							I		
		4-DOOR	PRE	I	0	59			4-DOOR	PRE	I	8	47
			POST	I	4	87				POST	I	12	58
				I							I		
	50K-250K	2-DOOR	PRE	I	10	285		50K-250K	2-DOOR	PRE	I	53	191
			POST	I	15	623				POST	I	99	485
				I							I		
		4-DOOR	PRE	I	24	481			4-DOOR	PRE	I	74	274
			POST	I	10	399				POST	I	56	350
				I							I		
	250K +	2-DOOR	PRE	I	18	271		250K +	2-DOOR	PRE	I	68	228
			POST	I	29	657				POST	I	103	577
				I							I		
		4-DOOR	PRE	I	19	405			4-DOOR	PRE	I	77	242
			POST	I	16	358				POST	I	68	281
				I							I		
OBJECT	LT 50K	2-DOOR	PRE	I	9	100	OBJECT	LT 50K	2-DOOR	PRE	I	25	84
			POST	I	19	361				POST	I	115	376
				I							I		
		4-DOOR	PRE	I	9	120			4-DOOR	PRE	I	54	112
			POST	I	11	219				POST	I	51	187
				I							I		
	50K-250K	2-DOOR	PRE	I	17	286		50K-250K	2-DOOR	PRE	I	83	232
			POST	I	48	784				POST	I	244	699
				I							I		
		4-DOOR	PRE	I	26	349			4-DOOR	PRE	I	123	259
			POST	I	20	367				POST	I	115	303
				I							I		
	250K +	2-DOOR	PRE	I	28	317		250K +	2-DOOR	PRE	I	176	324
			POST	I	78	847				POST	I	397	907
				I							I		
		4-DOOR	PRE	I	34	327			4-DOOR	PRE	I	187	301
			POST	I	26	366				POST	I	171	558

TABLE A-8 (Continued)

TAD: 5-7

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
OTHER MV	LT 50K	2-DOOR	PRE	125	73
			POST	408	339
		4-DOOR	PRE	163	69
			POST	286	227
	50K-250K	2-DOOR	PRE	95	121
			POST	330	509
		4-DOOR	PRE	122	142
			POST	147	264
	250K +	2-DOOR	PRE	105	111
			POST	315	452
		4-DOOR	PRE	96	125
			POST	108	174
PRKD CAR	LT 50K	2-DOOR	PRE	6	8
			POST	25	23
		4-DOOR	PRE	13	3
			POST	11	8
	50K-250K	2-DOOR	PRE	15	10
			POST	54	80
		4-DOOR	PRE	32	22
			POST	30	43
	250K +	2-DOOR	PRE	12	20
			POST	53	54
		4-DOOR	PRE	18	25
			POST	19	21
OBJECT	LT 50K	2-DOOR	PRE	36	15
			POST	146	75
		4-DOOR	PRE	52	18
			POST	85	28
	50K-250K	2-DOOR	PRE	68	43
			POST	198	137
		4-DOOR	PRE	84	43
			POST	89	56
	250K +	2-DOOR	PRE	101	41
			POST	217	165
		4-DOOR	PRE	66	38
			POST	72	47

THE TOTAL FREQUENCY IS 146449

TABLE A-9

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1974
RAW DATA FOR KABC/O INJURY DICHOTOMY

TAD: 1-2							TAD: 3-4						
ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I	INJURY (I) K+A+B+C	O	ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I	INJURY (I) K+A+B+C	O
OTHER MV	LT 50K	2-DOOR	PRE	I	19	739	OTHER MV	LT 50K	2-DOOR	PRE	I	119	456
			POST	I	58	2848				POST	I	446	1797
				I							I		
		4-DOOR	PRE	I	35	1146			4-DOOR	PRE	I	205	660
			POST	I	50	2258				POST	I	303	1261
	50K-250K	2-DOOR	PRE	I	93	3905		50K-250K	2-DOOR	PRE	I	342	1291
			POST	I	290	14192				POST	I	932	4841
				I							I		
		4-DOOR	PRE	I	162	5548			4-DOOR	PRE	I	459	1593
			POST	I	186	9457				POST	I	519	2845
	250K +	2-DOOR	PRE	I	181	5139		250K +	2-DOOR	PRE	I	454	1624
			POST	I	561	21649				POST	I	1507	6696
				I							I		
		4-DOOR	PRE	I	216	5966			4-DOOR	PRE	I	509	1721
			POST	I	254	11714				POST	I	666	3008
PKUP CAR	LT 50K	2-DOOR	PRE	I	3	47	PKUP CAR	LT 50K	2-DOOR	PRE	I	18	30
			POST	I	6	91				POST	I	18	114
				I							I		
		4-DOOR	PRE	I	0	59			4-DOOR	PRE	I	11	44
			POST	I	8	83				POST	I	17	53
	50K-250K	2-DOOR	PRE	I	15	280		50K-250K	2-DOOR	PRE	I	63	181
			POST	I	31	607				POST	I	133	451
				I							I		
		4-DOOR	PRE	I	29	476			4-DOOR	PRE	I	95	253
			POST	I	14	395				POST	I	85	321
	250K +	2-DOOR	PRE	I	22	267		250K +	2-DOOR	PRE	I	81	215
			POST	I	40	646				POST	I	148	532
				I							I		
		4-DOOR	PRE	I	25	399			4-DOOR	PRE	I	87	232
			POST	I	20	354				POST	I	88	261
OBJECT	LT 50K	2-DOOR	PRE	I	13	96	OBJECT	LT 50K	2-DOOR	PRE	I	30	79
			POST	I	34	346				POST	I	147	344
				I							I		
		4-DOOR	PRE	I	22	107			4-DOOR	PRE	I	66	100
			POST	I	15	215				POST	I	67	171
	50K-250K	2-DOOR	PRE	I	28	275		50K-250K	2-DOOR	PRE	I	109	206
			POST	I	74	758				POST	I	316	627
				I							I		
		4-DOOR	PRE	I	35	340			4-DOOR	PRE	I	146	236
			POST	I	33	354				POST	I	144	274
	250K +	2-DOOR	PRE	I	39	306		250K +	2-DOOR	PRE	I	216	284
			POST	I	117	808				POST	I	499	805
				I							I		
		4-DOOR	PRE	I	47	313			4-DOOR	PRE	I	214	274
			POST	I	40	352				POST	I	229	300

TABLE A-9 (Continued)

TAD: 5-7

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	I I	INJURY (I) K+A+B+C	O
OTHER MV	LT 50K	2-DOOR	PRE	I	141	57
			POST	I	489	258
				I		
		4-DOOR	PRE	I	177	55
			POST	I	338	175
				I		
	50K-250K	2-DOOR	PRE	I	122	94
			POST	I	449	390
				I		
		4-DOOR	PRE	I	156	108
			POST	I	207	204
				I		
	250K +	2-DOOR	PRE	I	131	85
			POST	I	439	328
				I		
		4-DOOR	PRE	I	130	91
			POST	I	159	123
				I		
PRKD CAR	LT 50K	2-DOOR	PRE	I	6	8
			POST	I	31	17
				I		
		4-DOOR	PRE	I	13	3
			POST	I	12	7
				I		
	50K-250K	2-DOOR	PRE	I	16	9
			POST	I	62	72
				I		
		4-DOOR	PRE	I	34	20
			POST	I	36	37
				I		
	250K +	2-DOOR	PRE	I	14	18
			POST	I	66	41
				I		
		4-DOOR	PRE	I	24	19
			POST	I	22	18
				I		
OBJECT	LT 50K	2-DOOR	PRE	I	40	11
			POST	I	161	60
				I		
		4-DOOR	PRE	I	58	12
			POST	I	94	19
				I		
	50K-250K	2-DOOR	PRE	I	75	36
			POST	I	226	109
				I		
		4-DOOR	PRE	I	94	33
			POST	I	101	44
				I		
	250K +	2-DOOR	PRE	I	113	29
			POST	I	274	108
				I		
		4-DOOR	PRE	I	74	30
			POST	I	85	34

THE TOTAL FREQUENCY IS 146449

TABLE A-10

FULLY CROSS CLASSIFIED TABLE
OF NEW YORK 1974 RAW DATA FOR
KA/BCO INJURY DICHOTOMY

MANUFACM	DRVAGEA	RDCLASSR	STYLES	PREPOSTP	I I	KAXBCOKA	(I)BCO
GM	15 - 24	HIGHWAY	2 DOOR	PRE	I	41	505
				POST	I	172	2544
					I		
			4 DOOR	PRE	I	33	314
				POST	I	32	633
					I		
		ROAD	2 DOOR	PRE	I	44	433
				POST	I	140	1762
					I		
			4 DOOR	PRE	I	29	260
				POST	I	21	411
					I		
		STREET	2 DOOR	PRE	I	28	424
				POST	I	97	1960
					I		
			4 DOOR	PRE	I	17	294
				POST	I	21	598
					I		
	25 - 49	HIGHWAY	2 DOOR	PRE	I	43	427
				POST	I	204	2869
					I		
			4 DOOR	PRE	I	37	327
				POST	I	61	1207
					I		
		ROAD	2 DOOR	PRE	I	33	261
				POST	I	95	1741
					I		
			4 DOOR	PRE	I	30	213
				POST	I	32	601
					I		
		STREET	2 DOOR	PRE	I	40	531
				POST	I	129	3049
					I		
			4 DOOR	PRE	I	30	533
				POST	I	50	1428
					I		
	50 +	HIGHWAY	2 DOOR	PRE	I	25	193
				POST	I	63	1310
					I		
			4 DOOR	PRE	I	11	182
				POST	I	50	1014
					I		
		ROAD	2 DOOR	PRE	I	11	135
				POST	I	46	793
					I		
			4 DOOR	PRE	I	3	101
				POST	I	17	457
					I		
		STREET	2 DOOR	PRE	I	7	225
				POST	I	36	1252
					I		
			4 DOOR	PRE	I	21	233
				POST	I	27	995
					I		

TABLE A-10 (Continued)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	I	KAXBCD (I) KA	BCD
FORD	15 - 24	HIGHWAY	2 DOOR	PRE	I	37	393
				POST	I	92	1423
			4 DOOR	PRE	I	13	170
				POST	I	24	350
		ROAD	2 DOOR	PRE	I	31	318
				POST	I	72	908
			4 DOOR	PRE	I	9	121
				POST	I	13	207
		STREET	2 DOOR	PRE	I	18	276
				POST	I	45	888
			4 DOOR	PRE	I	11	100
				POST	I	6	253
	25 - 49	HIGHWAY	2 DOOR	PRE	I	23	257
				POST	I	110	1461
			4 DOOR	PRE	I	19	167
				POST	I	38	602
		ROAD	2 DOOR	PRE	I	20	184
				POST	I	60	760
			4 DOOR	PRE	I	6	94
				POST	I	22	325
		STREET	2 DOOR	PRE	I	25	297
				POST	I	81	1233
			4 DOOR	PRE	I	10	196
				POST	I	15	500
	50 +	HIGHWAY	2 DOOR	PRE	I	7	111
				POST	I	36	615
			4 DOOR	PRE	I	8	92
				POST	I	19	455
		ROAD	2 DOOR	PRE	I	2	70
				POST	I	20	330
			4 DOOR	PRE	I	5	46
				POST	I	14	184
		STREET	2 DOOR	PRE	I	3	101
				POST	I	15	434
			4 DOOR	PRE	I	2	89
				POST	I	8	356

TABLE A-10 (Concluded)

MANUFACM	DRVAGEA	RDCLASSR	STYLES	PREPOSTP	I	KAXBCOKA	(I) BCO
OTHER	15 - 24	HIGHWAY	2 DOOR	PRE	I	28	220
				POST	I	112	1363
			4 DOOR	PRE	I	17	241
				POST	I	24	368
		ROAD	2 DOOR	PRE	I	21	149
				POST	I	93	854
			4 DOOR	PRE	I	15	162
				POST	I	17	235
		STREET	2 DOOR	PRE	I	16	164
				POST	I	54	867
			4 DOOR	PRE	I	14	199
				POST	I	8	306
	25 - 49	HIGHWAY	2 DOOR	PRE	I	17	174
				POST	I	96	1324
			4 DOOR	PRE	I	25	242
				POST	I	38	665
		ROAD	2 DOOR	PRE	I	8	84
				POST	I	45	684
			4 DOOR	PRE	I	12	126
				POST	I	23	307
		STREET	2 DOOR	PRE	I	14	192
				POST	I	65	1105
			4 DOOR	PRE	I	14	289
				POST	I	32	812
	50 +	HIGHWAY	2 DOOR	PRE	I	8	78
				POST	I	30	581
			4 DOOR	PRE	I	13	172
				POST	I	39	602
		ROAD	2 DOOR	PRE	I	1	63
				POST	I	20	349
			4 DOOR	PRE	I	6	62
				POST	I	16	270
		STREET	2 DOOR	PRE	I	9	98
				POST	I	27	458
			4 DOOR	PRE	I	10	151
				POST	I	18	526

THE TOTAL FREQUENCY IS 62843

TABLE A-11

FULLY CROSS CLASSIFIED TABLE
OF NEW YORK 1974 RAW DATA FOR
KAB/CO INJURY DICHOTOMY

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	I I	KABXCO (I) KAB	CO
GM	15 - 24	HIGHWAY	2 DOOR	PRE	I	140	406
				POST	I	541	2175
					I		
			4 DOOR	PRE	I	102	245
				POST	I	107	558
					I		
		ROAD	2 DOOR	PRE	I	139	338
				POST	I	438	1464
					I		
			4 DOOR	PRE	I	77	212
				POST	I	87	345
					I		
		STREET	2 DOOR	PRE	I	88	364
				POST	I	333	1724
					I		
			4 DOOR	PRE	I	61	250
				POST	I	85	534
					I		
	25 - 49	HIGHWAY	2 DOOR	PRE	I	111	359
				POST	I	580	2493
					I		
			4 DOOR	PRE	I	93	271
				POST	I	200	1068
					I		
		ROAD	2 DOOR	PRE	I	89	205
				POST	I	306	1530
					I		
			4 DOOR	PRE	I	67	176
				POST	I	96	537
					I		
		STREET	2 DOOR	PRE	I	115	456
				POST	I	454	2724
					I		
			4 DOOR	PRE	I	91	472
				POST	I	186	1292
					I		
	50 +	HIGHWAY	2 DOOR	PRE	I	53	165
				POST	I	211	1162
					I		
			4 DOOR	PRE	I	40	153
				POST	I	161	903
					I		
		ROAD	2 DOOR	PRE	I	37	109
				POST	I	131	708
					I		
			4 DOOR	PRE	I	24	80
				POST	I	65	409
					I		
		STREET	2 DOOR	PRE	I	36	196
				POST	I	164	1124
					I		
			4 DOOR	PRE	I	51	203
				POST	I	98	924
					I		

TABLE A-11 (Continued)

MANUFACM	DRVAGEA	ROCLASSR	STYLES	PREPOSTP	I	KABXCO KAB	(I) CO
FORD	15 - 24	HIGHWAY	2 DOOR	PRE	I	122	308
				POST	I	322	1193
			4 DOOR	PRE	I	46	137
				POST	I	71	303
		ROAD	2 DOOR	PRE	I	98	251
				POST	I	236	744
			4 DOOR	PRE	I	44	86
				POST	I	49	171
		STREET	2 DOOR	PRE	I	67	227
				POST	I	164	769
			4 DOOR	PRE	I	27	84
				POST	I	33	226
	25 - 49	HIGHWAY	2 DOOR	PRE	I	63	217
				POST	I	321	1250
			4 DOOR	PRE	I	46	140
				POST	I	101	539
		ROAD	2 DOOR	PRE	I	64	140
				POST	I	180	640
			4 DOOR	PRE	I	24	76
				POST	I	74	273
		STREET	2 DOOR	PRE	I	62	260
				POST	I	243	1071
			4 DOOR	PRE	I	30	176
				POST	I	63	452
	50 +	HIGHWAY	2 DOOR	PRE	I	32	86
				POST	I	111	540
			4 DOOR	PRE	I	25	79
				POST	I	82	392
		ROAD	2 DOOR	PRE	I	17	55
				POST	I	69	281
			4 DOOR	PRE	I	11	40
				POST	I	33	165
		STREET	2 DOOR	PRE	I	20	84
				POST	I	64	385
			4 DOOR	PRE	I	17	74
				POST	I	49	315

TABLE A-11 (Concluded)

MANUFACM	DRVAGEA	ROCLASSR	STYLES	PREPOSTP	KABXCO (I) KAB	CO
OTHER	15 - 24	HIGHWAY	2 DOOR	PRE	70	178
				POST	309	1166
			4 DOOR	PRE	68	190
				POST	101	291
		ROAD	2 DOOR	PRE	54	116
				POST	251	696
			4 DOOR	PRE	58	119
				POST	60	192
		STREET	2 DOOR	PRE	34	146
				POST	181	740
			4 DOOR	PRE	53	160
				POST	48	266
	25 - 49	HIGHWAY	2 DOOR	PRE	53	138
				POST	308	1112
			4 DOOR	PRE	62	205
				POST	124	379
		ROAD	2 DOOR	PRE	26	66
				POST	151	578
			4 DOOR	PRE	31	107
				POST	61	269
		STREET	2 DOOR	PRE	41	165
				POST	222	948
			4 DOOR	PRE	50	253
				POST	95	749
	50 +	HIGHWAY	2 DOOR	PRE	20	66
				POST	126	485
			4 DOOR	PRE	39	146
				POST	128	513
		ROAD	2 DOOR	PRE	9	55
				POST	92	277
			4 DOOR	PRE	17	51
				POST	53	233
		STREET	2 DOOR	PRE	18	89
				POST	79	406
			4 DOOR	PRE	23	138
				POST	67	477

THE TOTAL FREQUENCY IS 62843

TABLE A-12

FULLY CROSS CLASSIFIED TABLE
OF NEW YORK 1974 RAW DATA FOR
KABC/O INJURY DICHOTOMY

MANUFACM	DRVAGEA	RDCLASSR	STYLES	PREPOSTP	I I	KABCXO KABC	(I) O
GM	15 - 24	HIGHWAY	2 DOOR	PRE	I	201	349
				POST	I	845	1887
					I		
			4 DOOR	PRE	I	142	210
				POST	I	164	505
					I		
		ROAD	2 DOOR	PRE	I	195	284
				POST	I	642	1264
					I		
			4 DOOR	PRE	I	106	183
				POST	I	142	292
					I		
		STREET	2 DOOR	PRE	I	138	316
				POST	I	600	1462
					I		
			4 DOOR	PRE	I	110	202
				POST	I	156	464
					I		
	25 - 49	HIGHWAY	2 DOOR	PRE	I	179	296
				POST	I	987	2108
					I		
			4 DOOR	PRE	I	125	240
				POST	I	369	906
					I		
		ROAD	2 DOOR	PRE	I	121	176
				POST	I	556	1290
					I		
			4 DOOR	PRE	I	97	148
				POST	I	189	445
					I		
		STREET	2 DOOR	PRE	I	194	379
				POST	I	907	2287
					I		
			4 DOOR	PRE	I	163	402
				POST	I	376	1113
					I		
	50 +	HIGHWAY	2 DOOR	PRE	I	75	143
				POST	I	379	1006
					I		
			4 DOOR	PRE	I	56	137
				POST	I	282	787
					I		
		ROAD	2 DOOR	PRE	I	56	91
				POST	I	234	612
					I		
			4 DOOR	PRE	I	33	71
				POST	I	117	362
					I		
		STREET	2 DOOR	PRE	I	66	166
				POST	I	317	979
					I		
			4 DOOR	PRE	I	77	179
				POST	I	216	809
					I		

TABLE A-12 (Continued)

MANUFAC M	DRVAGE A	ROCLASS R	STYLE S	PREPOST P	I	KABCXO (I) KABC	D
FORD	15 - 24	HIGHWAY	2 DOOR	PRE	I	184	250
				POST	I	517	1005
			4 DOOR	PRE	I	65	118
				POST	I	103	274
		ROAD	2 DOOR	PRE	I	141	211
				POST	I	363	622
			4 DOOR	PRE	I	64	67
				POST	I	76	146
		STREET	2 DOOR	PRE	I	94	202
				POST	I	272	662
			4 DOOR	PRE	I	41	70
				POST	I	68	191
	25 - 49	HIGHWAY	2 DOOR	PRE	I	92	188
				POST	I	531	1049
			4 DOOR	PRE	I	75	113
				POST	I	184	459
		ROAD	2 DOOR	PRE	I	92	113
				POST	I	276	547
			4 DOOR	PRE	I	41	60
				POST	I	111	236
		STREET	2 DOOR	PRE	I	103	219
				POST	I	408	910
			4 DOOR	PRE	I	64	144
				POST	I	131	386
	50 +	HIGHWAY	2 DOOR	PRE	I	48	71
				POST	I	178	474
			4 DOOR	PRE	I	36	64
				POST	I	138	339
		ROAD	2 DOOR	PRE	I	26	46
				POST	I	115	236
			4 DOOR	PRE	I	20	31
				POST	I	54	146
		STREET	2 DOOR	PRE	I	36	68
				POST	I	121	329
			4 DOOR	PRE	I	27	65
				POST	I	97	269

TABLE A-12 (Concluded)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KABCXO (I) KABC	D
OTHER	15 - 24	HIGHWAY	2 DOOR	PRE	99	149
				POST	479	997
			4 DOOR	PRE	99	160
				POST	143	249
		ROAD	2 DOOR	PRE	76	94
				POST	371	582
			4 DOOR	PRE	72	105
				POST	89	164
		STREET	2 DOOR	PRE	57	125
				POST	292	631
			4 DOOR	PRE	73	141
				POST	79	236
	25 - 49	HIGHWAY	2 DOOR	PRE	84	107
				POST	482	945
			4 DOOR	PRE	101	167
				POST	225	481
		ROAD	2 DOOR	PRE	39	53
				POST	254	480
			4 DOOR	PRE	53	89
				POST	95	235
		STREET	2 DOOR	PRE	58	149
				POST	394	777
			4 DOOR	PRE	83	222
				POST	209	639
	50 +	HIGHWAY	2 DOOR	PRE	38	48
				POST	210	404
			4 DOOR	PRE	51	134
				POST	194	448
		ROAD	2 DOOR	PRE	21	45
				POST	140	231
			4 DOOR	PRE	22	46
				POST	93	194
		STREET	2 DOOR	PRE	27	80
				POST	151	336
			4 DOOR	PRE	47	115
				POST	127	418

THE TOTAL FREQUENCY IS 63137

TABLE A-13

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1973
RAW DATA FOR KA/BCO INJURY DICHOTOMY

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KA	BCO
1=29MPH	GM	LT 3000	2 DOOR	PRE	I	2	142
				POST	I	1	168
			4 DOOR	PRE	I	4	93
				POST	I	1	89
		3K=3599	2 DOOR	PRE	I	9	625
				POST	I	12	1567
			4 DOOR	PRE	I	9	620
				POST	I	6	604
		3600 +	2 DOOR	PRE	I	1	163
				POST	I	6	1050
			4 DOOR	PRE	I	8	423
				POST	I	7	1747
	FORD	LT 3000	2 DOOR	PRE	I	7	559
				POST	I	8	763
			4 DOOR	PRE	I	4	231
				POST	I	3	102
		3K=3599	2 DOOR	PRE	I	2	396
				POST	I	7	433
			4 DOOR	PRE	I	4	287
				POST	I	0	264
		3600 +	2 DOOR	PRE	I	2	151
				POST	I	1	299
			4 DOOR	PRE	I	2	233
				POST	I	3	515
	OTHER	LT 3000	2 DOOR	PRE	I	0	54
				POST	I	3	384
			4 DOOR	PRE	I	0	67
				POST	I	1	128
		3K=3599	2 DOOR	PRE	I	1	112
				POST	I	2	386
			4 DOOR	PRE	I	3	169
				POST	I	2	179
		3600 +	2 DOOR	PRE	I	0	42
				POST	I	2	122
			4 DOOR	PRE	I	0	88
				POST	I	1	384

TABLE A-13 (Continued)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
30-49MPH	GM	LT 3000	2 DOOR	PRE	3	103
				POST	5	120
			4 DOOR	PRE	5	66
				POST	5	46
		3K-3599	2 DOOR	PRE	12	467
				POST	21	1099
			4 DOOR	PRE	11	372
				POST	10	368
		3600 +	2 DOOR	PRE	1	111
				POST	18	698
			4 DOOR	PRE	12	241
				POST	33	960
	FORD	LT 3000	2 DOOR	PRE	18	389
				POST	16	590
			4 DOOR	PRE	5	146
				POST	3	72
		3K-3599	2 DOOR	PRE	13	339
				POST	8	337
			4 DOOR	PRE	6	195
				POST	4	147
		3600 +	2 DOOR	PRE	4	90
				POST	7	199
			4 DOOR	PRE	6	153
				POST	3	324
	OTHER	LT 3000	2 DOOR	PRE	1	35
				POST	10	258
			4 DOOR	PRE	1	27
				POST	3	59
		3K-3599	2 DOOR	PRE	2	103
				POST	5	290
			4 DOOR	PRE	3	89
				POST	5	115
		3600 +	2 DOOR	PRE	2	32
				POST	3	102
			4 DOOR	PRE	1	44
				POST	6	212

TABLE A-13 (Concluded)

VEHSPEED X	MANUFAC M	WEIGHT. W	STYLE S	PREPOST P	I I	INJURY (I) KA	BCO
50 MPH + GM		LT 3000	2 DOOR	PRE	I	1	22
				POST	I	4	25
					I		
			4 DOOR	PRE	I	4	16
				POST	I	0	9
					I		
		3K-3599	2 DOOR	PRE	I	14	136
				POST	I	44	349
					I		
			4 DOOR	PRE	I	5	81
				POST	I	9	103
					I		
		3600 +	2 DOOR	PRE	I	1	30
				POST	I	13	211
					I		
			4 DOOR	PRE	I	9	45
				POST	I	12	316
					I		
	FORD	LT 3000	2 DOOR	PRE	I	15	111
				POST	I	15	135
					I		
			4 DOOR	PRE	I	5	23
				POST	I	2	22
					I		
		3K-3599	2 DOOR	PRE	I	8	90
				POST	I	6	105
					I		
			4 DOOR	PRE	I	6	47
				POST	I	1	39
					I		
		3600 +	2 DOOR	PRE	I	2	29
				POST	I	7	78
					I		
			4 DOOR	PRE	I	6	37
				POST	I	6	113
					I		
	OTHER	LT 3000	2 DOOR	PRE	I	0	8
				POST	I	13	84
					I		
			4 DOOR	PRE	I	0	6
				POST	I	2	14
					I		
		3K-3599	2 DOOR	PRE	I	3	31
				POST	I	18	115
					I		
			4 DOOR	PRE	I	3	19
				POST	I	3	30
					I		
		3600 +	2 DOOR	PRE	I	1	8
				POST	I	0	40
					I		
			4 DOOR	PRE	I	4	6
				POST	I	8	86

THE TOTAL FREQUENCY IS 25901

TABLE A-14

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1973
RAW DATA FOR KAB/CO INJURY DICHOTOMY

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I	INJURY (I) KAB	CO
1=29MPH	GM	LT 3000	2 DOOR	PRE	I	5	139
				POST	I	8	161
					I		
			4 DOOR	PRE	I	8	89
				POST	I	4	86
					I		
		3K=3599	2 DOOR	PRE	I	39	595
				POST	I	56	1523
					I		
			4 DOOR	PRE	I	30	599
				POST	I	28	582
					I		
		3600 +	2 DOOR	PRE	I	7	157
				POST	I	29	1027
					I		
			4 DOOR	PRE	I	21	410
				POST	I	47	1707
					I		
	FORD	LT 3000	2 DOOR	PRE	I	36	530
				POST	I	34	737
					I		
			4 DOOR	PRE	I	15	220
				POST	I	6	99
					I		
		3K=3599	2 DOOR	PRE	I	16	382
				POST	I	28	412
					I		
			4 DOOR	PRE	I	19	272
				POST	I	5	259
					I		
		3600 +	2 DOOR	PRE	I	4	149
				POST	I	9	291
					I		
			4 DOOR	PRE	I	8	227
				POST	I	20	498
					I		
	OTHER.	LT 3000	2 DOOR	PRE	I	2	52
				POST	I	22	365
					I		
			4 DOOR	PRE	I	5	62
				POST	I	7	122
					I		
		3K=3599	2 DOOR	PRE	I	3	110
				POST	I	12	376
					I		
			4 DOOR	PRE	I	8	164
				POST	I	5	176
					I		
		3600 +	2 DOOR	PRE	I	3	39
				POST	I	8	116
					I		
			4 DOOR	PRE	I	3	85
				POST	I	20	365
					I		

TABLE A-14 (Continued)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KAB	CO
30-49MPH	GM	LT 3000	2 DOOR	PRE	I	14	92
				POST	I	25	100
			4 DOOR	PRE	I	12	59
				POST	I	8	43
		3K-3599	2 DOOR	PRE	I	63	416
				POST	I	110	1010
			4 DOOR	PRE	I	56	327
				POST	I	30	348
		3600 +	2 DOOR	PRE	I	14	98
				POST	I	62	654
			4 DOOR	PRE	I	26	227
				POST	I	93	900
	FORD	LT 3000	2 DOOR	PRE	I	70	337
				POST	I	70	536
			4 DOOR	PRE	I	22	129
				POST	I	16	59
		3K-3599	2 DOOR	PRE	I	47	305
				POST	I	34	311
			4 DOOR	PRE	I	23	178
				POST	I	12	139
		3600 +	2 DOOR	PRE	I	9	85
				POST	I	16	190
			4 DOOR	PRE	I	19	140
				POST	I	30	297
	OTHER	LT 3000	2 DOOR	PRE	I	8	28
				POST	I	32	236
			4 DOOR	PRE	I	4	24
				POST	I	9	53
		3K-3599	2 DOOR	PRE	I	14	91
				POST	I	26	269
			4 DOOR	PRE	I	13	79
				POST	I	14	106
		3600 +	2 DOOR	PRE	I	4	30
				POST	I	13	92
			4 DOOR	PRE	I	5	40
				POST	I	27	191

TABLE A-14 (Concluded)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KAB	CO
50 MPH +	GM	LT 3000	2 DOOR	PRE	I	5	18
				POST	I	9	20
					I		
			4 DOOR	PRE	I	7	13
				POST	I	1	8
					I		
		3K-3599	2 DOOR	PRE	I	38	112
				POST	I	93	300
					I		
			4 DOOR	PRE	I	10	76
				POST	I	26	86
					I		
		3600 +	2 DOOR	PRE	I	3	28
				POST	I	38	186
					I		
			4 DOOR	PRE	I	15	39
				POST	I	50	278
					I		
	FORD	LT 3000	2 DOOR	PRE	I	34	92
				POST	I	40	110
					I		
			4 DOOR	PRE	I	9	19
				POST	I	9	15
					I		
		3K-3599	2 DOOR	PRE	I	19	79
				POST	I	15	96
					I		
			4 DOOR	PRE	I	9	44
				POST	I	5	35
					I		
		3600 +	2 DOOR	PRE	I	10	21
				POST	I	16	69
					I		
			4 DOOR	PRE	I	12	31
				POST	I	15	104
					I		
	OTHER	LT 3000	2 DOOR	PRE	I	1	7
				POST	I	30	67
					I		
			4 DOOR	PRE	I	1	5
				POST	I	5	11
					I		
		3K-3599	2 DOOR	PRE	I	6	28
				POST	I	35	98
					I		
			4 DOOR	PRE	I	7	15
				POST	I	4	29
					I		
		3600 +	2 DOOR	PRE	I	1	8
				POST	I	1	39
					I		
			4 DOOR	PRE	I	5	5
				POST	I	16	78

THE TOTAL FREQUENCY IS 25901

TABLE A-15

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1973
RAW DATA FOR KABC/O INJURY DICHOTOMY

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I	INJURY (I) KABC	O
1=29MPH	GM	LT 3000	2 DOOR	PRE	I	13	131
				POST	I	15	154
					I		
			4 DOOR	PRE	I	12	85
				POST	I	9	81
					I		
		3K=3599	2 DOOR	PRE	I	70	564
				POST	I	123	1456
					I		
			4 DOOR	PRE	I	61	568
				POST	I	66	544
					I		
		3600 +	2 DOOR	PRE	I	10	154
				POST	I	69	987
					I		
			4 DOOR	PRE	I	42	389
				POST	I	107	1647
					I		
	FORD	LT 3000	2 DOOR	PRE	I	61	505
				POST	I	77	694
					I		
			4 DOOR	PRE	I	32	203
				POST	I	12	93
					I		
		3K=3599	2 DOOR	PRE	I	33	365
				POST	I	46	394
					I		
			4 DOOR	PRE	I	39	252
				POST	I	15	249
					I		
		3600 +	2 DOOR	PRE	I	9	144
				POST	I	27	273
					I		
			4 DOOR	PRE	I	21	214
				POST	I	42	476
					I		
	OTHER	LT 3000	2 DOOR	PRE	I	6	48
				POST	I	42	345
					I		
			4 DOOR	PRE	I	8	59
				POST	I	13	116
					I		
		3K=3599	2 DOOR	PRE	I	11	102
				POST	I	31	357
					I		
			4 DOOR	PRE	I	23	149
				POST	I	20	161
					I		
		3600 +	2 DOOR	PRE	I	4	38
				POST	I	12	112
					I		
			4 DOOR	PRE	I	9	79
				POST	I	42	343
					I		

TABLE A-15 (Continued)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
30-49MPH	GM	LT 3000	2 DOOR	PRE	20	86
				POST	33	92
			4 DOOR	PRE	17	54
				POST	15	36
		3K-3599	2 DOOR	PRE	106	373
				POST	198	922
			4 DOOR	PRE	80	303
				POST	68	310
		3600 +	2 DOOR	PRE	26	86
				POST	124	592
			4 DOOR	PRE	53	200
				POST	159	834
	FORD	LT 3000	2 DOOR	PRE	102	305
				POST	127	479
			4 DOOR	PRE	39	112
				POST	22	53
		3K-3599	2 DOOR	PRE	76	276
				POST	56	289
			4 DOOR	PRE	34	167
				POST	26	125
		3600 +	2 DOOR	PRE	14	80
				POST	35	171
			4 DOOR	PRE	30	129
				POST.	57	270
	OTHER	LT 3000	2 DOOR	PRE	9	27
				POST	51	217
			4 DOOR	PRE	7	21
				POST	15	47
		3K-3599	2 DOOR	PRE	25	80
				POST	47	248
			4 DOOR	PRE	19	73
				POST	25	95
		3600 +	2 DOOR	PRE	5	29
				POST	18	87
			4 DOOR	PRE	10	35
				POST	40	178

TABLE A-15 (Concluded)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I	INJURY KABC	(I) O
50 MPH +	GM	LT 3000	2 DOOR	PRE	I	6	17
				POST	I	10	19
			4 DOOR	PRE	I	8	12
				POST	I	1	8
		3K-3599	2 DOOR	PRE	I	42	108
				POST	I	126	267
			4 DOOR	PRE	I	21	65
				POST	I	41	71
		3600 +	2 DOOR	PRE	I	5	26
				POST	I	51	173
			4 DOOR	PRE	I	19	35
				POST	I	71	257
	FORD	LT 3000	2 DOOR	PRE	I	46	80
				POST	I	54	96
			4 DOOR	PRE	I	11	17
				POST	I	10	14
		3K-3599	2 DOOR	PRE	I	25	73
				POST	I	26	85
			4 DOOR	PRE	I	15	38
				POST	I	9	31
		3600 +	2 DOOR	PRE	I	11	20
				POST	I	25	60
			4 DOOR	PRE	I	14	29
				POST	I	24	95
	OTHER	LT 3000	2 DOOR	PRE	I	2	6
				POST	I	37	60
			4 DOOR	PRE	I	2	4
				POST	I	6	10
		3K-3599	2 DOOR	PRE	I	7	27
				POST	I	45	88
			4 DOOR	PRE	I	9	13
				POST	I	4	29
		3600 +	2 DOOR	PRE	I	1	8
				POST	I	3	37
			4 DOOR	PRE	I	6	4
				POST	I	27	67

THE TOTAL FREQUENCY IS 25901

TABLE A-16

FULLY CROSS CLASSIFIED TABLE OF
NORTH CAROLINA 1974 RAW DATA FOR
KA/BCO INJURY DICHOTOMY

MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) . KA	BCO
GM	LT 3000	2 DOOR	PRE	I	5	205
			POST	I	13	285
				I		
		4 DOOR	PRE	I	9	190
			POST	I	5	161
	3K-3599	2 DOOR	PRE	I	25	985
			POST	I	58	3087
				I		
		4 DOOR	PRE	I	31	996
			POST	I	25	1069
	3600 +	2 DOOR	PRE	I	7	253
			POST	I	47	2615
				I		
		4 DOOR	PRE	I	9	706
			POST	I	41	3445
FORD	LT 3000	2 DOOR	PRE	I	34	898
			POST	I	49	1630
				I		
		4 DOOR	PRE	I	19	328
			POST	I	11	209
	3K-3599	2 DOOR	PRE	I	18	654
			POST	I	19	740
				I		
		4 DOOR	PRE	I	13	465
			POST	I	15	446
	3600 +	2 DOOR	PRE	I	4	253
			POST	I	18	756
				I		
		4 DOOR	PRE	I	10	302
			POST	I	25	1209
OTHER	LT 3000	2 DOOR	PRE	I	1	81
			POST	I	27	740
				I		
		4 DOOR	PRE	I	3	92
			POST	I	3	184
	3K-3599	2 DOOR	PRE	I	3	201
			POST	I	17	847
				I		
		4 DOOR	PRE	I	4	245
			POST	I	11	377
	3600 +	2 DOOR	PRE	I	3	72
			POST	I	6	282
				I		
		4 DOOR	PRE	I	4	145
			POST	I	15	779

THE TOTAL FREQUENCY IS 26539

TABLE A-17

FULLY CROSS CLASSIFIED TABLE OF
NORTH CAROLINA 1974 RAW DATA FOR
KAB/CO INJURY DICHOTOMY

MANUFACM	WEIGHTW	STYLES	PREPOSTP	I	INJURY (I) KAB	CO
GM	LT 3000	2 DOOR	PRE	I	20	190
			POST	I	40	258
		4 DOOR	PRE	I	29	170
			POST	I	20	146
	3K-3599	2 DOOR	PRE	I	105	905
			POST	I	267	2878
		4 DOOR	PRE	I	110	917
			POST	I	93	1001
	3600 +	2 DOOR	PRE	I	20	240
			POST	I	171	2491
		4 DOOR	PRE	I	57	658
			POST	I	181	3305
FORD	LT 3000	2 DOOR	PRE	I	113	819
			POST	I	181	1498
		4 DOOR	PRE	I	47	300
			POST	I	29	195
	3K-3599	2 DOOR	PRE	I	70	602
			POST	I	59	700
		4 DOOR	PRE	I	33	445
			POST	I	35	426
	3600 +	2 DOOR	PRE	I	20	237
			POST	I	63	711
		4 DOOR	PRE	I	35	277
			POST	I	75	1159
OTHER	LT 3000	2 DOOR	PRE	I	5	77
			POST	I	97	670
		4 DOOR	PRE	I	9	86
			POST	I	16	171
	3K-3599	2 DOOR	PRE	I	21	183
			POST	I	83	781
		4 DOOR	PRE	I	22	227
			POST	I	29	359
	3600 +	2 DOOR	PRE	I	10	65
			POST	I	27	261
		4 DOOR	PRE	I	8	141
			POST	I	54	740

THE TOTAL FREQUENCY IS 26539

TABLE A-18

FULLY CROSS CLASSIFIED TABLE OF
NORTH CAROLINA 1974 RAW DATA FOR
KABC/O INJURY DICHOTOMY

MANUFAC M	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KABC	O
GM	LT 3000	2 DOOR	PRE	I	33	177
			POST	I	62	236
				I		
		4 DOOR	PRE	I	42	197
			POST	I	28	138
	3K-3599	2 DOOR	PRE	I	169	841
			POST	I	474	2671
				I		
		4 DOOR	PRE	I	193	834
			POST	I	153	941
	3600 +	2 DOOR	PRE	I	38	222
			POST	I	341	2321
				I		
		4 DOOR	PRE	I	99	616
			POST	I	407	3079
FORD	LT 3000	2 DOOR	PRE	I	166	766
			POST	I	320	1359
				I		
		4 DOOR	PRE	I	80	267
			POST	I	43	177
	3K-3599	2 DOOR	PRE	I	111	561
			POST	I	104	655
				I		
		4 DOOR	PRE	I	68	410
			POST	I	65	396
	3600 +	2 DOOR	PRE	I	47	210
			POST	I	106	668
				I		
		4 DOOR	PRE	I	46	266
			POST	I	152	1082
OTHER	LT 3000	2 DOOR	PRE	I	16	66
			POST	I	158	609
				I		
		4 DOOR	PRE	I	15	80
			POST	I	34	153
	3K-3599	2 DOOR	PRE	I	36	168
			POST	I	140	724
				I		
		4 DOOR	PRE	I	42	207
			POST	I	60	328
	3600 +	2 DOOR	PRE	I	15	60
			POST	I	46	242
				I		
		4 DOOR	PRE	I	19	130
			POST	I	105	689

THE TOTAL FREQUENCY IS 26539

TABLE A-19

FULLY CROSS CLASSIFIED TABLE OF
NORTH CAROLINA 1975 RAW DATA FOR
KA/BCO INJURY DICHOTOMY

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I	INJURY (I) KA	BCO
GM	MALE	LT 3000	2 DOOR	PRE	I	2	163
				POST	I	5	182
			4 DOOR	PRE	I	5	100
				POST	I	2	80
		3K-3599	2 DOOR	PRE	I	23	608
				POST	I	35	1977
			4 DOOR	PRE	I	12	533
				POST	I	14	706
		3600 +	2 DOOR	PRE	I	7	141
				POST	I	31	2020
			4 DOOR	PRE	I	5	392
				POST	I	35	2353
	FEMALE	LT 3000	2 DOOR	PRE	I	1	44
				POST	I	7	88
			4 DOOR	PRE	I	1	79
				POST	I	4	91
		3K-3599	2 DOOR	PRE	I	4	209
				POST	I	25	1159
			4 DOOR	PRE	I	5	319
				POST	I	13	584
		3600 +	2 DOOR	PRE	I	0	62
				POST	I	18	1194
			4 DOOR	PRE	I	5	189
				POST	I	25	1553

TABLE A-19 (Continued)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I	INJURY (I) KA	BCO
FORD	MALE	LT 3000	2 DOOR	PRE	I	13	586
				POST	I	24	1000
			4 DOOR	PRE	I	7	202
				POST	I	1	144
		3K-3599	2 DOOR	PRE	I	14	432
				POST	I	10	510
			4 DOOR	PRE	I	8	312
				POST	I	5	298
		3600 +	2 DOOR	PRE	I	5	127
				POST	I	5	595
			4 DOOR	PRE	I	4	190
				POST	I	22	877
	FEMALE	LT 3000	2 DOOR	PRE	I	6	290
				POST	I	26	795
			4 DOOR	PRE	I	6	136
				POST	I	8	145
		3K-3599	2 DOOR	PRE	I	9	185
				POST	I	11	326
			4 DOOR	PRE	I	5	171
				POST	I	5	192
		3600 +	2 DOOR	PRE	I	3	56
				POST	I	10	357
			4 DOOR	PRE	I	2	95
				POST	I	16	503

TABLE A-19 (Concluded)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KA	BCO
OTHER	MALE	LT 3000	2 DOOR	PRE	I	0	61
				POST	I	12	434
					I		
			4 DOOR	PRE	I	1	54
				POST	I	0	118
		3K-3599	2 DOOR	PRE	I	2	133
				POST	I	14	569
					I		
			4 DOOR	PRE	I	2	134
				POST	I	6	249
		3600 +	2 DOOR	PRE	I	2	43
				POST	I	5	186
					I		
			4 DOOR	PRE	I	0	94
				POST	I	12	571
	FEMALE	LT 3000	2 DOOR	PRE	I	1	33
				POST	I	9	326
					I		
			4 DOOR	PRE	I	2	41
				POST	I	3	82
		3K-3599	2 DOOR	PRE	I	3	72
				POST	I	6	265
					I		
			4 DOOR	PRE	I	1	117
				POST	I	7	174
		3600 +	2 DOOR	PRE	I	2	27
				POST	I	1	117
					I		
			4 DOOR	PRE	I	0	68
				POST	I	2	316

THE TOTAL FREQUENCY IS 28236

TABLE A-20

FULLY CROSS CLASSIFIED TABLE OF
NORTH CAROLINA 1975 RAW DATA FOR
KAB/CO INJURY DICHOTOMY

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KAB	CO
GM	MALE	LT 3000	2 DOOR	PRE	I	21	144
				POST	I	26	161
					I		
			4 DOOR	PRE	I	13	92
				POST	I	9	73
					I		
		3K-3599	2 DOOR	PRE	I	71	560
				POST	I	130	1882
					I		
			4 DOOR	PRE	I	46	499
				POST	I	51	669
					I		
		3600 +	2 DOOR	PRE	I	18	130
				POST	I	119	1932
					I		
			4 DOOR	PRE	I	32	365
				POST	I	144	2244
					I		
	FEMALE	LT 3000	2 DOOR	PRE	I	8	37
				POST	I	17	78
					I		
			4 DOOR	PRE	I	7	73
				POST	I	11	84
					I		
		3K-3599	2 DOOR	PRE	I	26	187
				POST	I	110	1074
					I		
			4 DOOR	PRE	I	28	296
				POST	I	55	542
					I		
		3600 +	2 DOOR	PRE	I	3	59
				POST	I	75	1137
					I		
			4 DOOR	PRE	I	19	175
				POST	I	121	1457
					I		

TABLE A-20 (Continued)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KAB	CO
FORD	MALE	LT 3000	2 DOOR	PRE	I	59	540
				POST	I	92	932
					I		
			4 DOOR	PRE	I	17	192
				POST	I	7	138
		3K-3599	2 DOOR	PRE	I	40	406
				POST	I	38	482
					I		
			4 DOOR	PRE	I	27	293
				POST	I	25	278
		3600 +	2 DOOR	PRE	I	10	122
				POST	I	33	567
					I		
			4 DOOR	PRE	I	21	173
				POST	I	65	834
	FEMALE	LT 3000	2 DOOR	PRE	I	35	261
				POST	I	107	714
					I		
			4 DOOR	PRE	I	19	123
				POST	I	30	123
		3K-3599	2 DOOR	PRE	I	29	165
				POST	I	28	309
					I		
			4 DOOR	PRE	I	15	161
				POST	I	18	179
		3600 +	2 DOOR	PRE	I	8	51
				POST	I	48	319
					I		
			4 DOOR	PRE	I	10	87
				POST	I	54	465

TABLE A-20 (Concluded)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KAB	CO
OTHER	MALE	LT 3000	2 DOOR	PRE	I	4	57
				POST	I	40	406
					I		
			4 DOOR	PRE	I	9	46
				POST	I	12	106
					I		
		3K-3599	2 DOOR	PRE	I	10	125
				POST	I	42	541
					I		
			4 DOOR	PRE	I	7	129
				POST	I	17	238
					I		
		3600 +	2 DOOR	PRE	I	4	41
				POST	I	20	171
					I		
			4 DOOR	PRE	I	9	85
				POST	I	36	547
					I		
	FEMALE	LT 3000	2 DOOR	PRE	I	3	31
				POST	I	49	286
					I		
			4 DOOR	PRE	I	7	36
				POST	I	9	76
					I		
		3K-3599	2 DOOR	PRE	I	12	63
				POST	I	29	242
					I		
			4 DOOR	PRE	I	10	108
				POST	I	26	155
					I		
		3600 +	2 DOOR	PRE	I	6	23
				POST	I	4	114
					I		
			4 DOOR	PRE	I	2	66
				POST	I	21	297

THE TOTAL FREQUENCY IS 28236

TABLE A-21

FULLY CROSS CLASSIFIED TABLE FOR
NORTH CAROLINA 1975 RAW DATA FOR
KABC/O INJURY DICHOTOMY

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I I	INJURY KABC	(I) O
GM	MALE	LT 3000	2 DOOR	PRE	I	27	138
				POST	I	36	151
					I		
			4 DOOR	PRE	I	15	90
				POST	I	12	70
					I		
		3K-3599	2 DOOR	PRE	I	103	528
				POST	I	223	1789
					I		
			4 DOOR	PRE	I	77	468
				POST	I	86	634
					I		
		3600 +	2 DOOR	PRE	I	22	126
				POST	I	236	1815
					I		
			4 DOOR	PRE	I	58	339
				POST	I	249	2139
					I		
	FEMALE	LT 3000	2 DOOR	PRE	I	15	30
				POST	I	27	68
					I		
			4 DOOR	PRE	I	16	64
				POST	I	22	73
					I		
		3K-3599	2 DOOR	PRE	I	51	162
				POST	I	220	964
					I		
			4 DOOR	PRE	I	66	258
				POST	I	121	476
					I		
		3600 +	2 DOOR	PRE	I	8	54
				POST	I	206	1006
					I		
			4 DOOR	PRE	I	28	166
				POST	I	257	1321
					I		

TABLE A-21 (Continued)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KABC	D
FORD	MALE	LT 3000	2 DOOR	PRE	I	96	503
				POST	I	154	870
					I		
			4 DOOR	PRE	I	30	179
				POST	I	16	129
					I		
		3K-3599	2 DOOR	PRE	I	58	388
				POST	I	70	450
					I		
			4 DOOR	PRE	I	44	276
				POST	I	38	265
					I		
		3600 +	2 DOOR	PRE	I	20	112
				POST	I	77	523
					I		
			4 DOOR	PRE	I	31	163
				POST	I	124	775
					I		
	FEMALE	LT 3000	2 DOOR	PRE	I	63	233
				POST	I	211	610
					I		
			4 DOOR	PRE	I	34	108
				POST	I	48	105
					I		
		3K-3599	2 DOOR	PRE	I	54	140
				POST	I	61	276
					I		
			4 DOOR	PRE	I	38	138
				POST	I	43	154
					I		
		3600 +	2 DOOR	PRE	I	14	45
				POST	I	86	281
					I		
			4 DOOR	PRE	I	16	81
				POST	I	102	417
					I		

TABLE A-21 (Concluded)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	I I	INJURY (I) KABC O
OTHER	MALE	LT 3000	2 DOOR	PRE	I	10 51
				POST	I	62 384
			4 DOOR	PRE	I	13 42
				POST	I	19 99
		3K-3599	2 DOOR	PRE	I	14 121
				POST	I	77 506
			4 DOOR	PRE	I	16 120
				POST	I	33 222
		3600 +	2 DOOR	PRE	I	6 39
				POST	I	29 162
			4 DOOR	PRE	I	14 80
				POST	I	66 517
	FEMALE	LT 3000	2 DOOR	PRE	I	8 26
				POST	I	83 252
			4 DOOR	PRE	I	11 32
				POST	I	17 68
		3K-3599	2 DOOR	PRE	I	21 54
				POST	I	50 221
			4 DOOR	PRE	I	20 98
				POST	I	33 148
		3600 +	2 DOOR	PRE	I	10 19
				POST	I	15 103
			4 DOOR	PRE	I	12 56
				POST	I	49 269

THE TOTAL FREQUENCY IS 28236

APPENDIX B

COMPLETE MARGINAL ASSOCIATIONS OF MODEL EFFECTS FOR STATE MASS ACCIDENT DATA

TABLE B-1

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR INJURY DICHOTOMY KA vs BCO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	184.75	1	0.000	151.73	1	0.000	138.18	2	0.000
Injury x Style	1.15	1	0.283	0.73	1	0.394	0.92	2	0.337
Injury x Accident Type	1,871.17	2	0.000	-	-	-	1,474.52	2	0.000
Injury x Driver Age	15.19	2	0.000	4.85	2	0.089	-	-	-
Injury x City Size	1,189.18	2	0.000	1,296.82	2	0.000	844.14	2	0.000
Injury x Road Type	-	-	-	491.11	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	7,235.74	2	0.000
Prepost x Style	4,860.68	1	0.000	4,878.59	1	0.000	4,569.23	1	0.000
Prepost x Accident Type	992.45	2	0.000	-	-	-	663.02	2	0.000
Prepost x Driver Age	730.43	2	0.000	588.60	2	0.000	-	-	-
Prepost x City Size	139.09	2	0.000	136.50	2	0.000	135.27	2	0.000
Prepost x Road Type	-	-	-	307.74	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	30.86	2	0.000
Style x Accident Type	126.33	2	0.000	-	-	-	118.53	2	0.000
Style x Driver Age	11,095.57	2	0.000	11,179.07	2	0.000	-	-	-
Style x City Size	570.90	2	0.000	604.32	2	0.000	558.01	2	0.000
Style x Road Type	-	-	-	0.79	2	0.673	-	-	-
Style x TAD	-	-	-	-	-	-	121.12	2	0.000
Accident Type x Driver Age	643.54	4	0.000	-	-	-	-	-	-
Accident Type x City Size	832.77	4	0.000	984.43	4	0.000	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	4	0.000
Driver Age x City Size	823.72	4	0.000	-	-	-	-	-	-
City Size x Road Type	-	-	-	24,816.45	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	734.40	4	0.000
City Size x TAD	-	-	-	-	-	-	3,326.20	4	0.000
Road Type x Driver Age	-	-	-	177.23	4	0.000	-	-	-
Injury x Prepost x Style	0.78	1	0.377	0.81*	1	0.369	0.21*	1	0.647
Injury x Prepost x Accident Type	2.32	2	0.313	-	-	-	-	-	-
Injury x Prepost x City Size	25.76	2	0.000	26.62*	2	0.000	-	-	-
Injury x Style x Accident Type	4.96	2	0.084	-	-	-	-	-	-
Injury x Style x City Size	1.79	2	0.408	3.31	2	0.191	-	-	-
Injury x Style x Driver Age	-	-	-	3.71	2	0.156	-	-	-
Injury x Accident Type x City Size	270.45	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	167.86*	4	0.000
Injury x Driver Age x City Size	16.67*	4	0.002	12.68	4	0.013	-	-	-
Injury x City Size x Road Type	-	-	-	148.76*	4	0.000	-	-	-

*Effect is specified directly in the model.

TABLE B-1 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x City Size x Accident Type	-	-	-	-	-	-	205.77*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	104.71*	4	0.000
Injury x Road Type x Driver Age	-	-	-	21.35*	4	0.000	-	-	-
Prepost x Style x Accident Type	65.34	2	0.000	-	-	-	14.33	2	0.001
Prepost x Style x Driver Age	1043.16	2	0.000	743.34*	2	0.000	-	-	-
Prepost x Style x City Size	12.39	2	0.002	16.05*	2	0.000	5.32*	2	0.070
Prepost x Style x TAD	-	-	-	-	-	-	4.69	2	0.096
Prepost x Accident Type x Driver Age	29.49	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x City Size	36.17	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	41.90	4	0.000
Prepost x City Size x Road Type	-	-	-	27.54*	4	0.000	-	-	-
Prepost x City Size x Driver Age	-	-	-	3.44*	4	0.487	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	57.92*	4	0.000
Prepost x City Size x TAD	-	-	-	-	-	-	38.10*	4	0.000
Prepost x Road Type x Driver Age	-	-	-	15.17*	4	0.004	-	-	-
Style x Accident Type x Driver Age	27.14	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	13.31	4.	0.010	-	-	-	-	-	-
Style x Accident Type x TAD	-	-	-	-	-	-	4.05	4	0.400
Style x Driver Age x City Size	61.38*	4	0.000	89.16	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	18.95	4	0.001	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86*	4	0.002
Style x Road Type x Driver Age	-	-	-	59.57	4	0.000	-	-	-
Accident Type x Driver Age x City Size	17.23*	8	0.028	-	-	-	-	-	-
City Size x Road Type x Driver Age	-	-	-	84.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98*	8	0.000
Injury x Prepost x Style x Accident Type	0.56	2	0.754	-	-	-	-	-	-
Injury x Prepost x Style x City Size	4.60	2	0.100	-	-	-	-	-	-
Injury x Prepost x Acc Type x City Size	9.48	4	0.050	-	-	-	-	-	-
Injury x Style x Acc Type x City Size	17.05	4	0.002	-	-	-	-	-	-
Injury x Style x City Size x Driver Age	-	-	-	12.33*	4	0.015	-	-	-
Prepost x Style x Acc Type x Driver Age	11.07*	4	0.026	-	-	-	-	-	-
Prepost x Style x Acc Type x City Size	6.88	4	0.142	-	-	-	-	-	-
Prepost x Style x Acc Type x TAD	-	-	-	-	-	-	10.60*	4	0.032
Style x City Size x Road Type x Driver Age	-	-	-	18.15*	8	0.020	-	-	-
Inj x Prepost x Style x Acc Type x City Size	11.59	4	0.021	-	-	-	-	-	-
SUMMARY OF MODEL	112.35	98	0.152	115.24	106	0.2537	141.42	122	0.1103

*Effect is specified directly in the model.

TABLE B-2

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR INJURY DICHOTOMY KAB vs CO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	370.72	1	0.000	378.46	1	0.000	347.04	1	0.000
Injury x Style	2.19	1	0.139	8.16	1	0.004	8.30	1	0.004
Injury x Accident Type	4,630.34	2	0.000	-	-	-	4,992.58	2	0.000
Injury x Driver Age	2.16	2	0.339	3.58	2	0.167	-	-	-
Injury x City Size	1,459.82	2	0.000	1,370.29	2	0.000	1,017.14	2	0.000
Injury x Road Type	-	-	-	564.33	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	19,452.24	2	0.000
Prepost x Style	4,860.68	1	0.000	4,878.59	1	0.000	4,569.23	1	0.000
Prepost x Accident Type	992.45	2	0.000	-	-	-	663.02	2	0.000
Prepost x Driver Age	730.43	2	0.000	588.60	2	0.000	-	-	-
Prepost x City Size	139.09	2	0.000	136.50	2	0.000	135.27	2	0.000
Prepost x Road Type	-	-	-	307.74	2	0.000	-	-	-
Prepost x TAO	-	-	-	-	-	-	30.86	2	0.000
Style x Accident Type	126.33	2	0.000	-	-	-	118.53	2	0.000
Style x Oriver Age	11,095.57	2	0.000	11,179.07	2	0.000	-	-	-
Style x City Size	570.90	2	0.000	604.32	2	0.000	558.01	2	0.000
Style x Road Type	-	-	-	0.78	2	0.676	-	-	-
Style x TAO	-	-	-	-	-	-	121.12	2	0.000
Accident Type x Oriver Age	643.54	4	0.000	-	-	-	-	-	-
Accident Type x City Size	332.77	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	4	0.000
Oriver Age x City Size	323.66	4	0.000	984.43	4	0.000	-	-	-
City Size x Road Type	-	-	-	24,316.45	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	734.40	4	0.000
City Size x TAD	-	-	-	-	-	-	3,326.20	4	0.000
Road Type x Oriver Age	-	-	-	177.20	4	0.000	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	2	0.000

TABLE B-2 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.68*	1	0.408	0.04	1	0.839	14.58*	1	0.000
Injury x Prepost x Accident Type	6.99	2	0.030	-	-	-	26.12*	2	0.000
Injury x Prepost x Driver Age	13.50*	2	0.001	21.55	2	0.000	-	-	-
Injury x Prepost x City Size	39.86	2	0.000	37.95	2	0.000	-	-	-
Injury x Prepost x Road Type	-	-	-	10.95	2	0.004	-	-	-
Injury x Style x Accident Type	12.90	2	0.002	-	-	-	-	-	-
Injury x Style x City Size	8.17	2	0.017	-	-	-	1.10*	2	0.578
Injury x Style x Driver Age	-	-	-	14.41	2	0.001	-	-	-
Injury x Accident Type x Oriver Age	12.04	4	0.017	-	-	-	-	-	-
Injury x Accident Type x City Size	504.00	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAO	-	-	-	-	-	-	242.48*	4	0.000
Injury x Oriver Age x City Size	31.68	4	0.000	16.07	4	0.003	-	-	-
Injury x City Size x Road Type	-	-	-	178.00*	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	353.53*	4	0.000
Injury x City Size x TAO	-	-	-	-	-	-	54.50*	4	0.000
Injury x Road Type x Driver Age	-	-	-	26.35*	4	0.000	-	-	-
Prepost x Style x Accident Type	65.34	2	0.000	-	-	-	14.33	2	0.001
Prepost x Style x Oriver Age	1,043.15	2	0.000	743.34	2	0.000	-	-	-
Prepost x Style x City Size	12.39*	2	0.002	16.07*	2	0.000	5.32*	2	0.070
Prepost x Style x TAO	-	-	-	-	-	-	4.69	2	0.096
Prepost x Accident Type x Driver Age	29.49	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x City Size	36.17	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x TAO	-	-	-	-	-	-	41.90	4	0.000
Prepost x City Size x Road Type	-	-	-	27.52*	4	0.000	-	-	-
Prepost x City Size x Oriver Age	-	-	-	3.48	4	0.482	-	-	-
Prepost x Road Type x Oriver Age	-	-	-	15.17*	4	0.004	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	57.92	4	0.000
Prepost x City Size x TAO	-	-	-	-	-	-	38.10	4	0.000

*Effect is specified directly in the model.

TABLE B-2 (Concluded)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x Accident Type x Driver Age	27.14	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	13.31	4	0.001	-	-	-	-	-	-
Style x Accident Type x TAD	-	-	-	-	-	-	4.05	4	0.400
Style x City Size x Road Type	-	-	-	18.95	4	0.001	-	-	-
Style x City Size x Oriver Age	-	-	-	89.16	4	0.000	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86*	4	0.002
Style x Road Type x Oriver Age	-	-	-	59.55	4	0.000	-	-	-
Accident Type x Driver Age x City Size	17.20	8	0.028	-	-	-	-	-	-
City Size x Road Type x Oriver Age	-	-	-	84.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98*	8	0.000
Injury x Prepost x Accident Type x City Size	9.94*	4	0.041	-	-	-	-	-	-
Injury x Prepost x Style x Oriver Age	-	-	-	14.32*	2	0.001	-	-	-
Injury x Prepost x City Size x Driver Age	-	-	-	10.34*	4	0.035	-	-	-
Injury x Style x Accident Type x City Size	17.38*	4	0.002	-	-	-	-	-	-
Inj. x Acc.Type x Driver Age x City Size	23.20*	8	0.003	-	-	-	-	-	-
Prepost x Style x Accident Type x Dr. Age	11.07*	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60*	4	0.032
Style x City Size x Road Type x Oriver Age	-	-	-	18.15*	8	0.020	-	-	-
SUMMARY OF MOOEL	91.50	96	0.6108	118.89	104	0.1508	129.82	116	0.1794

*Effect is specified directly in the model.

TABLE B-3

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR INJURY DICHOTOMY KABC vs O TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	320.73	1	0.000	284.91	1	0.000	230.17	1	0.000
Injury x Style	8.73	1	0.003	14.71	1	0.000	7.52	1	0.006
Injury x Accident Type	4,522.61	2	0.000	-	-	-	4,831.43	2	0.000
Injury x Oriver Age	6.62	2	0.037	0.27	2	0.872	-	-	-
Injury x City Size	1,286.50	2	0.000	1,184.21	2	0.000	944.74	2	0.000
Injury x Road Type	-	-	-	445.13	2	0.000	-	-	-
Injury x TAO	-	-	-	-	-	-	24,149.57	2	0.000
Prepost x Style	4,860.68	1	0.000	4,878.59	1	0.000	4,569.23	1	0.000
Prepost x Accident Type	992.45	2	0.000	-	-	-	663.02	2	0.000
Prepost x Driver Age	730.43	2	0.000	588.60	2	0.000	-	-	-
Prepost x City Size	139.09	2	0.000	136.50	2	0.000	135.27	2	0.000
Prepost x Road Type	-	-	-	307.74	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	30.86	2	0.000
Style x Accident Type	126.33	2	0.000	-	-	-	118.53	2	0.000
Style x Driver Age	11,095.57	2	0.000	11,179.07	2	0.000	-	-	-
Style x City Size	570.90	2	0.000	604.32	2	0.000	558.01	2	0.000
Style x Road Type	-	-	-	0.78	2	0.676	-	-	-
Style x TAD	-	-	-	-	-	-	121.12	2	0.000
Accident Type x Driver Age	643.54	4	0.000	-	-	-	-	-	-
Accident Type x City Size	832.77	4	0.000	984.43	4	0.000	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	4	0.000
Driver Age x City Size	823.69	4	0.000	-	-	-	-	-	-
City Size x Road Type	-	-	-	24,816.45	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	734.40	4	0.000
City Size x TAD	-	-	-	-	-	-	3,326.20	4	0.000

TABLE B-3 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.46*	1	0.496	0.26*	1	0.608	13.40*	1	0.000
Injury x Prepost x Accident Type	11.45	2	0.003	-	-	-	18.10	2	0.000
Injury x Prepost x Driver Age	19.15*	2	0.000	11.57	2	0.003	-	-	-
Injury x Prepost x City Size	25.97	2	0.000	32.54	2	0.000	13.05	2	0.002
Injury x Prepost x Road Type	-	-	-	8.53	2	0.014	-	-	-
Injury x Prepost x TAD	-	-	-	-	-	-	4.07	2	0.131
Injury x Style x Accident Type	10.82	2	0.004	-	-	-	-	-	-
Injury x Style x Driver Age	15.30	2	0.000	17.17	2	0.000	-	-	-
Injury x Style x City Size	17.01	2	0.000	1.95	2	0.378	-	-	-
Injury x Style x Road Type	-	-	-	2.23	2	0.327	-	-	-
Injury x Accident Type x City Size	378.95	4	0.000	-	-	-	205.82	4	0.000
Injury x Driver Age x City Size	28.15	4	0.000	18.23	4	0.001	-	-	-
Injury x City Size x Road Type	-	-	-	184.11	4	0.000	-	-	-
Injury x City Size x TAD	-	-	-	-	-	-	39.63	4	0.000
Injury x Road Type x Driver Age	-	-	-	16.54	4	0.002	-	-	-
Prepost x Style x Accident Type	65.34	2	0.000	-	-	-	14.33	2	0.001
Prepost x Style x Driver Age	1,043.17	2	0.000	743.34*	2	0.000	-	-	-
Prepost x Style x City Size	12.39*	2	0.002	16.07*	2	0.000	5.32*	2	0.070
Prepost x Style x Road Type	-	-	-	0.42	2	0.812	-	-	-
Prepost x Style x TAD	-	-	-	-	-	-	4.69	2	0.096
Prepost x Accident Type x Driver Age	29.49	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x City Size	36.17	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	41.90	4	0.000
Prepost x City Size x Road Type	-	-	-	27.52*	4	0.000	-	-	-
Prepost x City Size x Driver Age	-	-	-	3.48	4	0.480	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	57.92	4	0.000
Prepost x City Size x TAD	-	-	-	-	-	-	38.10	4	0.000
Prepost x Road Type x Driver Age	-	-	-	15.17*	4	0.004	-	-	-
Style x Accident Type x Driver Age	27.14	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	13.31	4	0.010	-	-	-	-	-	-
Style x Accident Type x TAD	-	-	-	-	-	-	4.05	4	0.400

*Effect is specified directly in the model.

TABLE B-3 (Concluded)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x City Size x Road Type	-	-	-	18.94	4	0.001	-	-	-
Style x City Size x Driver Age	61.38	4	0.000	89.25	4	0.000	-	-	-
Style x Road Type x Driver Age	-	-	-	59.55	4	0.000	-	-	-
Accident Type x Driver Age x City Size	17.25*	8	0.028	84.74	8	0.000	-	-	-
City Size x Road Type x Driver Age	-	-	-	-	-	-	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98	8	0.000
Injury x Prepost x Accident Type x City Size	10.13*	4	0.038	-	-	-	6.91	4	0.141
Injury x Prepost x City Size x Driver Age	-	-	-	11.68*	4	0.020	-	-	-
Injury x Prepost x City Size x TAD	-	-	-	-	-	-	6.31	4	0.177
Injury x Prepost x Accident Type x TAD	-	-	-	-	-	-	2.00	4	0.736
Injury x Style x Accident Type x City Size	12.66*	4	0.013	-	-	-	-	-	-
Injury x Style x Driver Age x City Size	10.97*	4	0.027	2.45	4	0.654	-	-	-
Injury x Style x City Size x Road Type	-	-	-	5.87	4	0.209	-	-	-
Injury x Style x Road Type x Driver Age	-	-	-	0.62	4	0.960	-	-	-
Injury x City Size x Road Type x Driver Age	-	-	-	11.77	8	0.162	-	-	-
Injury x City Size x Accident Type x TAD	-	-	-	-	-	-	10.05	8	0.262
Prepost x Style x Accident Type x Driver Age	11.05*	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60*	4	0.032
Prepost x City Size x Accident Type x TAD	-	-	-	-	-	-	7.20	8	0.515
Style x City Size x Road Type x Driver Age	-	-	-	18.15	8	0.020	-	-	-
Inj x Style x City Size x Rd Type x Dr Age	-	-	-	17.13*	8	0.029	-	-	-
Inj x Prepost x City Size x Acc Type x TAD	-	-	-	-	-	-	17.95*	8	0.022
SUMMARY OF MODEL	93.47	102	0.7149	82.05	74	0.2440	95.46	80	0.1144

*Effect is specified directly in the model.

TABLE B-4

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE THREE INJURY DICHOTOMIES NEW YORK 1974 DRIVERS-ONLY SAMPLE

Effect	KA vs BCO			KAB vs CO			KABC vs O		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	95.59	1	0.000	209.79	1	0.000	137.46	1	0.000
Injury x Style	23.85	1	0.000	47.95	1	0.000	55.32	1	0.000
Injury x Rd Cl	123.51*	2	0.000	274.18	2	0.000	159.54	2	0.000
Injury x Age	57.11*	2	0.000	162.51	2	0.000	95.39*	2	0.000
Injury x Mfg	17.26	2	0.000	70.39	2	0.000	57.36	2	0.000
Prepost x Style	879.34	1	0.000	879.34	1	0.000	885.18	1	0.000
Prepost x Rd Cl	56.98	2	0.000	56.98	2	0.000	58.18	2	0.000
Prepost x Age	260.75	2	0.000	260.75	2	0.000	265.65	2	0.000
Prepost x Weight	49.69	2	0.000	49.69	2	0.000	50.80	2	0.000
Style x Rd Cl	195.16	2	0.000	195.16	2	0.000	198.05	2	0.000
Style x Age	1579.48	2	0.000	1579.84	2	0.000	1582.21	2	0.000
Style x Mfg	333.28	2	0.000	333.28	2	0.000	333.61	2	0.000
Rd Cl x Age	635.39	4	0.000	635.39	4	0.000	638.11	4	0.000
Rd Cl x Mfg	144.86	4	0.000	144.86	4	0.000	144.14	4	0.000
Age x Mfg	113.69	4	0.000	113.69	4	0.000	115.88	4	0.000
Injury x Prepost x Style	6.64*	1	0.010	9.99*	1	0.002	5.92*	1	0.015
Injury x Prepost x Rd Cl	-	-	-	-	-	-	9.68*	2	0.008
Injury x Prepost x Mfg	7.67*	2	0.022	15.12*	2	0.001	10.31*	2	0.006
Injury x Style x Rd Cl	-	-	-	8.67*	2	0.013	-	-	-
Injury x Style x Age	-	-	-	10.40*	2	0.006	-	-	-
Injury x Rd Cl x Age	-	-	-	-	-	-	9.61*	4	0.048
Prepost x Style x Rd Cl	2.45	2	0.029	2.45	2	0.294	2.42	2	0.298
Prepost x Style x Age	114.30	2	0.000	114.30	2	0.000	113.75	2	0.000
Prepost x Style x Mfg	111.25	2	0.000	111.25	2	0.000	112.87	2	0.000
Prepost x Rd Cl x Age	17.80*	4	0.001	17.80*	4	0.001	17.05*	4	0.002
Prepost x Rd Cl x Mfg	9.26	4	0.055	9.26	4	0.055	9.14	4	0.058
Prepost x Age x Mfg	12.29	4	0.015	12.29	4	0.015	12.87	4	0.012
Style x Rd Cl x Age	23.69*	4	0.000	23.69*	4	0.000	23.49*	4	0.000
Style x Rd Cl x Mfg	15.19	4	0.004	15.19	4	0.004	15.35	4	0.004
Style x Age x Mfg	9.65	4	0.047	9.65	4	0.047	10.22	4	0.037
Prepost x Style x Rd Cl x Mfg	13.00*	4	0.011	13.00*	4	0.011	13.33*	4	0.010
Prepost x Style x Age x Mfg	13.70*	4	0.008	13.70*	4	0.008	13.85*	4	0.008
SUMMARY OF MODEL	138.49	132	0.3321	133.98	128	0.3409	141.47	126	0.1637

*Effect is specified directly in the model.

TABLE B-5

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KA vs BCO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	11.54	1	0.001	10.34	1	0.001	6.07	1	0.018
Injury x Style	0.98	1	0.322	1.04	1	0.307	1.71	1	0.192
Injury x Weight	17.34	2	0.000	44.87*	2	0.000	17.46*	2	0.000
Injury x Est Speed	476.51	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	4.00*	1	0.046
Prepost x Style	71.20	1	0.000	117.65	1	0.000	93.19	1	0.000
Prepost x Weight	1020.65	2	0.000	1272.48	2	0.000	1646.50	2	0.000
Prepost x Mfg	711.23	2	0.000	535.10	2	0.000	566.95	2	0.000
Prepost x Est Speed	21.13	2	0.000	-	-	-	-	-	-
Prepost x Sex	-	-	-	-	-	-	66.08	1	0.000
Style x Weight	2757.12	2	0.000	2493.78	2	0.000	2304.72	2	0.000
Style x Mfg	217.36	2	0.000	186.11	2	0.000	185.00	2	0.000
Style x Est Speed	88.64	2	0.000	-	-	-	-	-	-
Style x Sex	-	-	-	-	-	-	28.93	1	0.000
Weight x Mfg	3684.54	4	0.000	4000.89	4	0.000	4405.18	4	0.000
Weight x Est Speed	28.88	4	0.000	-	-	-	-	-	-
Weight x Sex	-	-	-	-	-	-	27.74	2	0.000
Mfg x Est Speed	20.34*	4	0.000	-	-	-	-	-	-
Sex x Mfg	-	-	-	-	-	-	1.73	2	0.421
Injury x Prepost x Style	5.79*	1	0.016	1.93*	1	0.165	1.75*	1	0.187
Injury x Weight x Est Speed	9.99*	4	0.041	-	-	-	-	-	-
Prepost x Style x Weight	82.32	2	0.000	72.51	2	0.000	19.51	2	0.000
Prepost x Style x Mfg	25.94	2	0.000	81.27	2	0.000	46.57	2	0.000
Prepost x Style x Est Speed	6.00*	2	0.050	-	-	-	-	-	-
Prepost x Weight x Mfg	201.70	4	0.000	214.94	4	0.000	290.84	4	0.000
Style x Weight x Mfg	123.11	4	0.000	266.54	4	0.000	275.29	4	0.000
Prepost x Style x Sex	-	-	-	-	-	-	19.96*	1	0.000
Prepost x Weight x Sex	-	-	-	-	-	-	6.25*	2	0.044
Prepost x Sex x Mfg	-	-	-	-	-	-	31.07*	2	0.000
Style x Weight x Sex	-	-	-	-	-	-	20.16	2	0.000
Style x Sex x Mfg	-	-	-	-	-	-	17.03	2	0.000
Weight x Sex x Mfg	-	-	-	-	-	-	10.06	4	0.039
Prepost x Style x Weight x Mfg	75.99*	4	0.000	88.20*	4	0.000	78.61*	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74*	4	0.000
SUMMARY OF MODEL	162.56	152	0.264	34.49	30	0.262	88.83	77	0.168

*Effect is specified directly in the model.

TABLE B-6

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KAB vs CO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	30.98	1	0.000	32.57	1	0.000	25.71	1	0.000
Injury x Style	11.27	1	0.001	22.17	1	0.000	4.11	1	0.043
Injury x Weight	69.27	2	0.000	119.35	2	0.000	79.53	2	0.000
Injury x Mfg	-	-	-	18.36	2	0.000	26.00	2	0.000
Injury x Est Speed	898.49	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	45.97	1	0.000
Prepost x Style	71.18	1	0.000	117.65	1	0.000	93.19	1	0.000
Prepost x Weight	1020.65	2	0.000	1272.48	2	0.000	1646.52	2	0.000
Prepost x Mfg	711.25	2	0.000	535.10	2	0.000	566.97	2	0.000
Prepost x Est Speed	21.13	2	0.000	-	-	-	-	-	-
Prepost x Sex	-	-	-	-	-	-	66.08	1	0.000
Style x Weight	2757.17	2	0.000	2493.78	2	0.000	2304.74	2	0.000
Style x Mfg	217.37	2	0.000	186.11	2	0.000	185.02	2	0.000
Style x Est Speed	88.65*	2	0.000	-	-	-	-	-	-
Style x Sex	-	-	-	-	-	-	28.92	1	0.000
Weight x Mfg	3684.57	4	0.000	4000.89	4	0.000	4405.21	4	0.000
Weight x Est Speed	28.88	4	0.000	-	-	-	-	-	-
Weight x Sex	-	-	-	-	-	-	27.73	2	0.000
Mfg x Est Speed	20.32*	4	0.000	-	-	-	-	-	-
Sex x Mfg	-	-	-	-	-	-	1.73	2	0.421
Injury x Prepost x Style	0.47*	1	0.494	6.87*	1	0.009	2.32*	1	0.127
Injury x Prepost x Weight	1.05	2	0.591	-	-	-	8.81*	2	0.012
Injury x Prepost x Est Speed	1.72	2	0.423	-	-	-	-	-	-
Injury x Weight x Est Speed	2.69	4	0.611	-	-	-	-	-	-
Injury x Weight x Mfg	-	-	-	10.65*	4	0.031	13.58	4	0.009
Injury x Weight x Sex	-	-	-	-	-	-	2.51	2	0.285
Injury x Sex x Mfg	-	-	-	-	-	-	7.93	2	0.019
Prepost x Style x Weight	82.30	2	0.000	72.51	2	0.000	19.50	2	0.000
Prepost x Style x Mfg	25.94	2	0.000	81.27	2	0.000	46.58	2	0.000
Prepost x Weight x Mfg	201.71	4	0.000	214.94	4	0.000	290.85	4	0.000
Prepost x Weight x Est Speed	4.73	4	0.316	-	-	-	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96*	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06*	2	0.000

*Effect is specified directly in the model.

TABLE B-6 (Continued)

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x Weight x Mfg	123.11	4	0.000	266.64	4	0.000	275.27	4	0.000
Style x Weight x Sex	-	-	-	-	-	-	20.16	2	0.000
Style x Sex x Mfg	-	-	-	-	-	-	17.05	2	0.000
Weight x Sex x Mfg	-	-	-	-	-	-	10.06	4	0.039
Injury x Prepost X Wt x Est Speed	11.33*	4	0.023	-	-	-	-	-	-
Prepost x Style x Weight x Mfg	75.98*	4	0.000	88.20*	4	0.000	78.60*	4	0.000
Injury x Weight x Sex x Mfg	-	-	-	-	-	-	12.34*	4	0.015
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74*	4	0.000
SUMMARY OF MODEL	161.69	142	0.124	29.60	24	0.198	67.07	63	0.400

*Effect is specified directly in the model.

TABLE B-7

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KABC vs O NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	24.17	1	0.000	24.29	1	0.000	14.97	1	0.001
Injury x Style	5.11	1	0.024	14.94	1	0.000	6.08	1	0.014
Injury x Weight	70.55*	2	0.000	109.44*	2	0.000	75.72*	2	0.000
Injury x Est Speed	918.70*	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	244.97*	1	0.000
Injury x Mfg	-	-	-	-	-	-	38.36	2	0.000
Prepost x Style	71.18	1	0.000	117.65	1	0.000	93.19	1	0.000
Prepost x Weight	1020.65	2	0.000	1272.48	2	0.000	1646.52	2	0.000
Prepost x Mfg	711.25	2	0.000	535.10	2	0.000	566.97	2	0.000
Prepost x Est Speed	21.13	2	0.000	-	-	-	-	-	-
Prepost x Sex	-	-	-	-	-	-	66.08	1	0.000
Style x Weight	2757.17	2	0.000	2493.78	2	0.000	2304.74	2	0.000
Style x Mfg	217.34	2	0.000	186.11	2	0.000	185.02	2	0.000
Style x Est Speed	88.65	2	0.000	-	-	-	-	-	-
Style x Sex	-	-	-	-	-	-	28.92	1	0.000
Weight x Mfg	3684.57	4	0.000	-	-	-	4405.21	4	0.000
Weight x Est Speed	28.88*	4	0.000	4000.89	4	0.000	-	-	-
Weight x Sex	-	-	-	-	-	-	27.73	2	0.000
Mfg x Est Speed	20.32*	4	0.000	-	-	-	-	-	-
Sex x Mfg	-	-	-	-	-	-	1.74	-	0.421
Injury x Prepost x Style	2.01*	1	0.157	6.96 *	1	0.008	0.06*	1	0.811
Injury x Prepost x Mfg	-	-	-	-	-	-	7.65*	2	0.022
Prepost x Style X Weight	82.30	2	0.000	72.51	2	0.000	19.50	2	0.000
Prepost x Style x Mfg	25.94	2	0.000	81.27	2	0.000	46.58	2	0.000
Prepost x Style x Est Speed	6.00*	2	0.050	-	-	-	-	-	-
Prepost x Weight x Mfg	201.71	4	0.000	214.94	4	0.000	290.85	4	0.000
Prepost x Style x Sex	-	-	-	-	-	-	19.96*	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06*	2	0.000
Style x Weight x Mfg	123.11	4	0.000	266.64	4	0.000	275.27	4	0.000
Style x Weight X Sex	-	-	-	-	-	-	20.16	2	0.000
Style x Sex x Mfg	-	-	-	-	-	-	17.05	2	0.000
Weight x Sex x Mfg	-	-	-	-	-	-	10.06	4	0.039
Prepost x Style x Weight x Mfg	75.98*	4	0.000	88.20*	4	0.000	78.60*	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74*	4	0.000
SUMMARY OF MODEL	174.60	156	0.147	29.51	30	0.491	76.34	75	0.435

*Effect is specified directly in the model.

TABLE B-8

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KA vs BCO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	71.47	1	0.000	39.63	1	0.000	49.29	1	0.000
Injury x Style	0.0	1	1.000	0.20	1	0.652	0.86	1	0.353
Injury x Accident Type	1,198.00	2	0.000	-	-	-	835.89	2	0.000
Injury x Driver Age	3.59*	2	0.166	-	-	-	-	-	-
Injury x City Size	862.73	2	0.000	901.15	2	0.000	464.02	2	0.000
Injury x Road Type	-	-	-	331.06	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	4,161.54	2	0.000
Prepost x Style	755.43	1	0.000	803.77	1	0.000	681.56	1	0.000
Prepost x Accident Type	276.04	2	0.000	-	-	-	93.64	2	0.000
Prepost x Driver Age	398.59	2	0.000	305.59	2	0.000	-	-	-
Prepost x City Size	34.56	2	0.000	14.86	2	0.001	23.50	2	0.000
Prepost x Road Type	-	-	-	78.68	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	2.80	2	0.247
Style x Accident Type	107.44	2	0.000	-	-	-	118.40	2	0.000
Style x Driver Age	9,740.99	2	0.000	7,477.56	2	0.000	-	-	-
Style x City Size	395.12	2	0.000	322.24	2	0.000	235.44	2	0.000
Style x Road Type	-	-	-	6.10	2	0.047	-	-	-
Style x TAD	-	-	-	-	-	-	110.61*	2	0.000
Accident Type x Driver Age	463.41	4	0.000	-	-	-	-	-	-
Accident Type x City Size	628.48	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	4,003.20	4	0.000
City Size x Road Type	-	-	-	15,475.01	4	0.000	-	-	-
City Size x Driver Age	539.23	4	0.000	644.73	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	427.76	4	0.000
City Size x TAD	-	-	-	-	-	-	1,793.45	4	0.000
Road Type x Driver Age	-	-	-	95.31	4	0.000	-	-	-

*Effect is specified directly in the model.

TABLE B-8 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.42*	1	0.518	0.06*	1	0.804	0.14*	1	0.705
Injury x Prepost x City Size	-	-	-	17.93*	2	0.000	-	-	-
Injury x Prepost x Accident Type	-	-	-	-	-	-	2.78	2	0.250
Injury x Prepost x TAD	-	-	-	-	-	-	7.59	2	0.022
Injury x Style x Accident Type	1.36	2	0.507	-	-	-	6.35*	2	0.042
Injury x Style x City Size	7.09	2	0.029	-	-	-	-	-	-
Injury x Accident Type x City Size	179.82	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	108.32	4	0.000
Injury x City Size x Road Type	-	-	-	34.48*	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	123.71*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	69.86*	4	0.000
Prepost x Style x Accident Type	29.14	2	0.000	-	-	-	8.55*	2	0.014
Prepost x Style x Driver Age	280.18*	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	7.23*	2	0.267	12.57*	2	0.002	6.90*	2	0.032
Prepost x Accident Type x Driver Age	12.56*	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03	4	0.000
Prepost x City Size x Road Type	-	-	-	13.10*	4	0.011	-	-	-
Prepost x City Size x Accident Type	17.13*	4	0.002	-	-	-	13.13*	4	0.011
Prepost x City Size x TAD	-	-	-	-	-	-	12.08*	4	0.017
Style x Accident Type x Driver Age	20.51*	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	9.54	4	0.049	-	-	-	-	-	-
Style x Driver Age x City Size	41.69*	4	0.000	65.71*	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98*	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74*	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51*	8	0.000
Injury x Style x Accident Type x City Size	17.81*	4	0.001	-	-	-	-	-	-
Injury x Prepost x Accident Type x TAD	-	-	-	-	-	-	10.94*	4	0.027
SUMMARY OF MODEL	147.04	134	0.2083	148.72	144	0.3766	132.00	126	0.3393

*Effect is specified directly in the model.

TABLE B-9

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DOCHOTOMY KAB vs CO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	118.91	1	0.000	128.23	1	0.000	113.21	1	0.000
Injury x Style	5.65	1	0.017	20.46	1	0.000	12.90	1	0.000
Injury x Accident Type	2,993.90	2	0.000	-	-	-	3,159.08	2	0.000
Injury x Driver Age	1.55	2	0.461	1.05	2	0.591	-	1	1
Injury x City Size	1,054.67	2	0.000	878.27	2	0.000	505.63	2	0.000
Injury x Road Type	-	-	-	375.81	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	681.56	1	0.000
Prepost x Style	755.43	1	0.000	-	-	-	93.64	2	0.000
Prepost x Accident Type	276.04	2	0.000	305.59	2	0.000	-	-	-
Prepost x Driver Age	398.59	2	0.000	14.86	2	0.001	22.50	2	0.000
Prepost x City Size	34.56	2	0.000	14.86	2	0.001	-	-	-
Prepost x Road Type	-	-	-	76.68	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	2.80	2	0.247
Style x Accident Type	107.44	2	0.000	-	-	-	-	-	-
Style x Driver Age	9,740.99	2	0.000	7,477.56	2	0.000	-	-	-
Style x City Size	395.11	2	0.000	322.24	2	0.000	235.44	2	0.000
Style x Road Type	-	-	-	6.10	2	0.048	-	-	-
Style x TAD	-	-	-	-	-	-	110.61*	2	0.000
Accident Type x Driver Age	463.41	4	0.000	-	-	-	-	-	-
Accident Type x City Size	628.48	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	4,003.20	4	0.000
Driver Age x City Size	539.23	4	0.000	644.73	4	0.000	-	-	-
City Size x Road Type	-	-	-	15,475.01	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	427.76	4	0.000
City Size x TAD	-	-	-	-	-	-	1,793.39	4	0.000
Road Type x Driver Age	-	-	-	95.30	4	0.000	-	-	-
Injury x Prepost x Style	0.14*	1	0.707	0.68*	1	0.409	7.93*	1	0.005
Injury x Prepost x City Size	15.99*	2	0.000	19.80*	2	0.000	12.41*	2	0.002
Injury x Prepost x Driver Age	-	-	-	11.98*	2	0.002	-	-	-

*Effect is specified directly in the model.

TABLE B-9 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Style x Accident Type	9.27	2	0.010	-	-	-	9.15*	2	0.010
Injury x Style x Driver Age	5.86*	2	0.053	9.77*	2	0.008	-	-	-
Injury x Style x City Size	10.02	2	0.007	-	-	-	-	-	-
Injury x Accident Type x City Size	368.70	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	154.15*	4	0.000
Injury x Driver Age x City Size	28.43*	4	0.000	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	116.13*	2	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	195.01*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	41.52*	4	0.000
Injury x Road Type x Driver Age	-	-	-	19.58*	4	0.001	-	-	-
Prepost x Style x Accident Type	29.14*	2	0.000	-	-	-	8.55*	2	0.014
Prepost x Style x Driver Age	280.18*	2	0.000	132.49*	2	0.000	-	-	-
Prepost x Style x City Size	7.23*	2	0.027	12.57*	2	0.002	6.92*	2	0.031
Prepost x Accident Type x Driver Age	12.56*	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x City Size	17.13*	4	0.002	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03*	4	0.000
Prepost x City Size x Road Type	-	-	-	13.10*	4	0.011	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	13.12*	4	0.011
Style x Accident Type x Driver Age	20.51*	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	9.54	4	0.049	-	-	-	-	-	-
Style x Driver Age x City Size	41.69*	4	0.000	65.71*	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98*	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74*	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51*	8	0.000
Injury x Style x Accident Type x City Size	12.78*	4	0.012	-	-	-	-	-	-
SUMMARY OF MODEL	130.56	126	0.3722	146.17	134	0.2228	155.25	136	0.1237

*Effect is specified directly in the model.

TABLE B-10

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KABC vs CO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	115.34	1	0.000	96.50	1	0.000	67.96	1	0.000
Injury x Style	11.29	1	0.001	19.54	1	0.000	11.18	1	0.001
Injury x Accident Type	2,932.70	2	0.000	-	-	-	2,981.45	2	0.000
Injury x Driver Age	4.70	2	0.095	1.15	2	0.563	-	-	-
Injury x City Size	944.24	2	0.000	726.86	2	0.000	476.94	2	0.000
Injury x Road Type	-	-	-	284.22	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	13,987.60	2	0.000
Prepost x Style	755.43	1	0.000	803.77	1	0.000	681.56	1	0.000
Prepost x Accident Type	276.04	2	0.000	-	-	-	93.64	2	0.000
Prepost x Driver Age	398.59	2	0.000	305.59	2	0.000	-	-	-
Prepost x City Size	34.56	2	0.000	14.86	2	0.001	23.50	2	0.000
Prepost x Road Type	-	-	-	73.68	2	0.000	-	-	-
Prepost x TAO	-	-	-	-	-	-	2.80	2	0.247
Style x Accident Type	107.44	2	0.000	-	-	-	118.40	2	0.000
Style x Driver Age	9,740.99	2	0.000	7,477.56	2	0.000	-	-	-
Style x City Size	395.11	2	0.000	322.24	2	0.000	235.44	2	0.000
Style x Road Type	-	-	-	6.10	2	0.047	-	-	-
Style x TAD	-	-	-	-	-	-	110.61*	2	0.000
Accident Type x Driver Age	463.46	4	0.000	-	-	-	-	-	-
Accident Type x City Size	628.48	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	4,003.20	4	0.000
Driver Age x City Size	539.23	4	0.000	644.73	4	0.000	-	-	-
City Size x Road Type	-	-	-	15,475.01	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	427.76	4	0.000
City Size x TAO	-	-	-	-	-	-	1,793.39	4	0.000
Road Type x Driver Age	-	-	-	95.31	4	0.000	-	-	-
Injury x Prepost x Style	0.02	1	0.890	3.09*	1	0.079	6.02*	1	0.014
Injury x Prepost x Accident Type	1.93	2	0.380	-	-	-	-	-	-
Injury x Prepost x City Size	10.81	2	0.004	13.06*	2	0.002	-	-	-
Injury x Style x Accident Type	5.96	2	0.051	-	-	-	7.35*	2	0.025
Injury x Style x Driver Age	9.51*	2	0.009	10.71	2	0.005	-	-	-
Injury x Style x City Size	19.18	2	0.000	1.30	2	0.521	-	-	-
Injury x Style x Road Type	-	-	-	3.45	2	0.178	-	-	-
Injury x Accident Type x City Size	277.63	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAO	-	-	-	-	-	-	149.11*	4	0.000

*Effect is specified directly in the model.

TABLE B-10 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Driver Age x City Size	23.88*	4	0.000	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	122.15	4	0.000	-	-	-
Injury x City Size x Driver Age	-	-	-	12.61	4	0.013	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	150.86*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	32.97*	4	0.000
Injury x Road Type x Driver Age	-	-	-	11.51	4	0.021	-	-	-
Prepost x Style x Accident Type	29.14	2	0.000	-	-	-	8.55*	2	0.014
Prepost x Style x Oriver Age	280.18*	2	0.000	132.49*	2	0.000	-	-	-
Prepost x Style x City Size	7.23	2	0.027	12.57*	2	0.002	6.90*	2	0.032
Prepost x Accident Type x Driver Age	12.56*	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x City Size	17.13	4	0.002	-	-	-	-	-	-
Prepost x Accident Type x TAO	-	-	-	-	-	-	23.03*	4	0.000
Prepost x City Size x Road Type	-	-	-	13.09*	4	0.011	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	13.12*	4	0.011
Style x Accident Type x Oriver Age	20.51*	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	9.54	4	0.049	-	-	-	-	-	-
Style x Driver Age x City Size	41.69*	4	0.000	65.71	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98	4	0.001	-	-	-
Style x Road Type x Driver Age	-	-	-	17.67	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51*	3	0.000
Injury x Prepost x Style x Accident Type	0.41	2	0.814	-	-	-	-	-	-
Injury x Prepost x Style x City Size	1.85	2	0.397	-	-	-	-	-	-
Injury x Prepost x Acc. Type x City Size	4.36	4	0.359	-	-	-	-	-	-
Injury x Style x Accident Type x City Size	8.09	4	0.088	-	-	-	-	-	-
Injury x Style x City Size x Road Type	-	-	-	3.01	4	0.556	-	-	-
Injury x Style x City Size x Driver Age	-	-	-	2.80	4	0.591	-	-	-
Injury x Style x Road Type x Driver Age	-	-	-	3.15	4	0.533	-	-	-
Injury x City Size x Road Type x Driver Age	-	-	-	10.15	8	0.255	-	-	-
Prepost x Style x Accident Type x City Size	2.77	4	0.597	-	-	-	-	-	-
Style x City Size x Road Type x Oriver Age	-	-	-	12.57	8	0.128	-	-	-
Inj. x Prepost x Style x Acc.Type x City Size	10.81*	4	0.029	-	-	-	-	-	-
Inj. x Style x City Size x Rd. Type x Dr.Age	-	-	-	20.33*	8	0.009	-	-	-
SUMMARY OF MODEL	119.69	108	0.2079	92.81	88	0.3422	148.45	138	0.2566

*Effect is specified directly in the model.

APPENDIX C

SUMMARY OF EFFECTIVENESS RESULTS FOR OBSERVED UNADJUSTED STATE MASS ACCIDENT DATA

TABLE C-1

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS
OBSERVED, NOT ADJUSTED
TOTAL CASES = 159693

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	996	0.6	1131	0.7	1165	0.7	687	0.4	3979	2.5
B+C+O	30005	18.8	54517	34.1	37638	23.6	33554	21.0	155714	97.5
K+A+B	3076	1.9	3985	2.5	3596	2.3	2220	1.4	12877	8.1
C+O	27925	17.5	51663	32.4	35207	22.0	32021	20.1	146816	91.9
K+A+B+C	4256	2.7	5928	3.7	4935	3.1	3305	2.1	18424	11.5
O	26745	16.7	49720	31.1	33868	21.2	30936	19.4	141269	88.5
K+A+B+C+O	31001	19.4	55648	34.8	38803	24.3	34241	21.4	159693	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	5.11	6.08	-4.87	15.09
K+A+B	-3.25	3.58	-9.11	2.64
K+A+B+C	-2.29	2.90	-7.05	2.47

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	3.21	2.03	3.00	2.01	2.49
K+A+B	9.92	7.16	9.27	6.48	8.06
K+A+B+C	13.73	10.65	12.72	9.65	11.54

TABLE C-2

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS
OBSERVED, NOT ADJUSTED
TOTAL CASES = 161908

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	734	0.5	1311	0.8	899	0.6	723	0.4	3667	2.3
B+C+O	24312	15.0	64745	40.0	30381	18.8	38803	24.0	158241	97.7
K+A+B	2582	1.6	4790	3.0	2902	1.8	2555	1.6	12829	7.9
C+O	22464	13.9	61266	37.8	28378	17.5	36971	22.8	149079	92.1
K+A+B+C	5533	2.2	7166	4.4	3973	2.5	3911	2.4	18583	11.5
O	21513	13.3	58890	36.4	27307	16.9	35615	22.0	143325	88.5
K+A+B+C+O	25046	15.5	66056	40.8	31280	19.3	39526	24.4	161908	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-6.69	7.17	-18.45	5.07
K+A+B	-1.03	3.53	-6.82	4.77
K+A+B+C	1.23	2.82	-3.39	5.86

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.93	1.98	2.87	1.83	2.26
K+A+B	10.31	7.25	9.28	6.46	7.92
K+A+B+C	14.11	10.85	12.70	9.89	11.48

TABLE C-3

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS
OBSERVED, NOT ADJUSTED
TOTAL CASES = 146449

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	515	0.4	1185	0.8	584	0.4	593	0.4	2877	2.0
B+C+O	17755	12.1	65904	45.0	22377	15.3	37536	25.6	143572	98.0
K+A+B	1847	1.3	4984	3.4	2263	1.5	2377	1.6	11471	7.8
C+O	16423	11.2	62105	42.4	20698	14.1	35752	24.4	134978	92.2
K+A+B+C	2503	1.7	7554	5.2	3123	2.1	3792	2.6	16972	11.6
O	15767	10.8	59535	40.7	19838	13.5	34337	23.4	129477	88.4
K+A+B+C+O	18270	12.5	67089	45.8	22961	15.7	38129	26.0	146449	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-2.84	8.00	-15.96	10.28
K+A+B	-16.28	4.45	-23.58	-8.97
K+A+B+C	-12.47	3.51	-18.23	-6.70

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.82	1.77	2.54	1.56	1.96
K+A+B	10.11	7.43	9.86	6.23	7.83
K+A+B+C	13.70	11.26	13.60	9.95	11.59

TABLE C-4

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 NEW YORK
OBSERVED, NOT ADJUSTED
TOTAL CASES = 62816

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	560	0.9	2055	3.3	420	0.7	658	1.0	3693	5.9
B+C+O	6363	10.1	32917	52.4	5176	8.2	14667	23.3	59123	94.1
K+A+B	1678	2.7	6587	10.5	1277	2.0	2377	3.8	11919	19.0
C+O	5245	8.3	28385	45.2	4319	6.9	12975	20.6	50924	81.0
K+A+B+C	2540	4.0	11021	17.5	1943	3.1	4227	6.7	19731	31.3
O	4418	7.0	24112	38.2	3683	5.8	11193	17.7	43406	68.7
K+A+B+C+O	6923	11.0	34972	55.7	5596	8.9	15325	24.4	62816	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-27.38	9.67	-43.24	-11.51
K+A+B	-14.62	4.50	-22.00	-7.25
K+A+B+C	-8.31	3.10	-13.39	-3.23

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	8.09	5.88	7.51	4.29	5.88
K+A+B	24.24	18.84	22.82	15.48	18.97
K+A+B+C	36.50	31.37	34.54	27.41	31.25

TABLE C-5

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 N. CAROLINA
OBSERVED, NOT ADJUSTED
TOTAL CASES = 25901

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	125	0.5	255	1.0	126	0.5	139	0.5	645	2.5
B+C+O	4378	16.9	10007	38.6	3824	14.8	7047	27.2	25256	97.5
K+A+B	475	1.8	871	3.4	372	1.4	512	2.0	2230	8.6
C+O	4028	15.6	9391	36.3	3578	13.8	6674	25.8	23671	91.4
K+A+B+C	745	2.9	1508	5.8	641	2.5	946	3.7	3840	14.8
O	3758	14.5	8754	33.8	3309	12.8	6240	24.1	22061	85.2
K+A+B+C+O	4503	17.4	10262	39.6	3950	15.3	7186	27.7	25901	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-49.82	24.39	-89.82	-9.82
K+A+B	-6.75	9.06	-21.60	8.11
K+A+B+C	-9.71	6.86	-20.97	1.54

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.78	2.48	3.19	1.93	2.49
K+A+B	10.55	8.49	9.42	7.12	8.61
K+A+B+C	16.54	14.69	16.23	13.16	14.83

TABLE C-6

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 N. CAROLINA
OBSERVED, NOT ADJUSTED
TOTAL CASES = 26539

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	100	0.4	254	1.0	102	0.4	151	0.6	607	2.3
B+C+O	5602	15.6	10982	41.4	3469	13.1	7879	29.7	25932	97.7
K+A+B	384	1.4	988	3.7	350	1.3	528	2.0	2250	8.5
C+O	5318	12.5	10248	38.6	3221	12.1	7502	28.3	24289	91.5
K+A+B+C	631	2.4	1751	6.6	604	2.3	1047	3.9	4033	15.2
O	3071	11.6	9485	35.7	2967	11.2	6983	26.3	22506	84.8
K+A+B+C+O	5702	15.9	11236	42.3	3571	13.5	8030	30.3	26539	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-29.19	22.24	-65.05	7.28
K+A+B	-26.88	11.07	-45.03	-8.73
K+A+B+C	-18.86	7.52	-31.19	-6.52

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	2.70	2.26	2.86	1.88	2.29
K+A+B	10.37	8.79	9.80	6.58	8.48
K+A+B+C	17.04	15.58	16.91	13.04	15.20

TABLE C-7

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1975 N. CAROLINA
OBSERVED, NOT ADJUSTED
TOTAL CASES = 28236

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	97	0.3	254	0.9	71	0.3	180	0.6	602	2.1
B+C+O	3272	11.6	12100	42.9	3226	11.4	9036	32.0	27634	97.9
K+A+B	367	1.3	1007	3.6	298	1.1	711	2.5	2383	8.4
C+O	3002	10.6	11347	40.2	2999	10.6	8505	30.1	25853	91.6
K+A+B+C	600	2.1	1923	6.8	539	1.9	1335	4.7	4397	15.6
O	2769	9.8	10431	36.9	2758	9.8	7881	27.9	23839	84.4
K+A+B+C+O	3369	11.9	12354	43.8	3297	11.7	9216	32.6	28236	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	20.05	14.55	-3.81	43.91
K+A+B	12.01	7.72	-0.65	24.66
K+A+B+C	1.16	6.25	-9.09	11.42

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.88	2.06	2.15	1.95	2.13
K+A+B	10.89	8.15	9.04	7.71	8.44
K+A+B+C	17.81	15.57	16.35	14.49	15.57

TABLE C-8

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS 65-71
OBSERVED, NOT ADJUSTED
TOTAL CASES = 109145

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	544	0.5	923	0.8	468	0.4	582	0.5	2517	2.3
B+C+O	17889	16.4	44234	40.5	16340	15.0	28165	25.8	106628	97.7
K+A+B	1681	1.5	5245	5.0	1442	1.3	1909	1.7	8275	7.6
C+O	16752	15.3	41914	38.4	15366	14.1	26838	24.6	100870	92.4
K+A+B+C	2387	2.2	4803	4.4	2027	1.9	2829	2.6	12046	11.0
O	16046	14.7	40554	37.0	14781	13.5	25918	23.7	97099	89.0
K+A+B+C+O	18433	16.9	45157	41.4	16808	15.4	28747	26.3	109145	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	4.42	7.78	-8.54	17.17
K+A+B	-1.84	4.50	-9.23	5.54
K+A+B+C	-0.72	3.64	-6.09	5.24

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	2.95	2.04	2.78	2.02	2.31
K+A+B	9.12	7.18	8.58	6.64	7.58
K+A+B+C	12.95	10.64	12.06	9.84	11.04

TABLE C-9

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS 65-71
OBSERVED, NOT ADJUSTED
TOTAL CASES = 101844

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	421	0.4	860	0.8	394	0.4	535	0.5	2210	2.2
B+C+O	15459	15.2	41756	41.0	14975	14.7	27444	26.9	99634	97.8
K+A+B	1552	1.5	3132	3.1	1299	1.3	1842	1.8	7825	7.7
C+O	14328	14.1	39484	38.8	14070	13.8	26137	25.7	94019	92.3
K+A+B+C	2160	2.1	4656	4.6	1825	1.8	2842	2.8	11483	11.3
O	13720	13.5	37960	37.3	13544	13.3	25137	24.7	90361	88.7
K+A+B+C+O	15880	15.6	42616	41.8	15369	15.1	27979	27.5	101844	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-2.48	9.03	-17.29	12.34
K+A+B	3.35	4.42	-3.90	10.61
K+A+B+C	6.03	3.51	0.28	11.78

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.65	2.02	2.56	1.91	2.17
K+A+B	9.77	7.35	8.45	6.58	7.68
K+A+B+C	13.60	10.93	11.87	10.16	11.28

TABLE C-10

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS 65-71
OBSERVED, NOT ADJUSTED
TOTAL CASES = 85112

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	323	0.4	653	0.8	290	0.3	409	0.5	1675	2.0
B+C+O	11934	14.0	35711	42.0	11903	14.0	23889	28.1	83437	98.0
K+A+B	1180	1.4	2831	3.3	1153	1.4	1612	1.9	6776	8.0
C+O	11077	13.0	33533	39.4	11040	13.0	22686	26.7	78336	92.0
K+A+B+C	1031	1.9	4253	5.0	1604	1.9	2540	3.0	10028	11.8
O	10626	12.5	32111	37.7	10589	12.4	21758	25.6	75084	88.2
K+A+B+C+O	12257	14.4	36364	42.7	12193	14.3	24298	28.5	85112	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	3.19	9.83	-12.93	19.31
K+A+B	-15.42	5.72	-24.80	-6.04
K+A+B+C	-10.70	4.48	-18.05	-3.36

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.64	1.80	2.38	1.68	1.97
K+A+B	9.63	7.79	9.46	6.63	7.96
K+A+B+C	13.51	11.70	13.16	10.45	11.78

APPENDIX D

CONFIDENCE LIMITS FOR A DOUBLE RATIO OF PROBABILITIES

CONFIDENCE LIMITS FOR A DOUBLE RATIO OF PROBABILITIES

1. Objective

To estimate a confidence interval for

$$R = \frac{p_1}{p_2} : \frac{p_3}{p_4} = \frac{p_1 p_4}{p_2 p_3}, \tag{1}$$

where $p_i = x_i/n_i$, and the x_i are binomially distributed random variables.

2. Approach

We write

$$R = \frac{\pi_1 \pi_4}{\pi_2 \pi_3} \frac{(1+\varepsilon_1)(1+\varepsilon_4)}{(1+\varepsilon_2)(1+\varepsilon_3)}, \tag{2}$$

where the π_i are the expected values of the p_i.

Then we study

$$r = \frac{(1+\varepsilon_1)(1+\varepsilon_4)}{(1+\varepsilon_2)(1+\varepsilon_3)} \tag{3}$$

by expanding the fraction in power series in ε_2 and ε_3. These series expressions hold only if $|\varepsilon| < 1$; that requires p to be restricted to the range $0 \ldots 2\pi$, or x to the range $0 \ldots 2n\pi$. Since $\sigma(x) = \sqrt{n\pi(1-\pi)}$, this is a $\pm 2\sigma$ range for $n\pi = 4(1-\pi)$. Since $n\pi = m$ is usually much larger than 4, the restriction is violated only by a minimal fraction of all cases.
We calculate the first four moments of r to various degrees of approximation and compare them. Finally, we will explore by numerical examples how large the data base from which r is estimated has to be in order to use the simple approximation.

3. Some Basic Formulas

The ε are implicitly defined as:

$$\varepsilon = \frac{p-\pi}{\pi} . \tag{4}$$

Since $p = x/n$

$$\varepsilon = \frac{x-n\pi}{n\ \pi} . \tag{5}$$

Therefore, for the central moments the relation

$$\mu_i(\varepsilon) = \frac{\mu_i(x)}{(n\pi)^i} \tag{6}$$

holds. Since x was assumed to be binomially distributed,

$$\left.\begin{aligned} \mu_1(x) &= 0 \\ \mu_2(x) &= n\pi(1-\pi) \\ \mu_3(x) &= n\pi(1-\pi)(1-2\pi) \\ \mu_4(x) &= 3n^2\pi^2(1-\pi)^2 + n\pi(1-\pi)(1-6\pi(1-\pi)), \end{aligned}\right\} \tag{7}$$

therefore

$$\left.\begin{aligned} \mu_1(\varepsilon) &= 0 \\ \mu_2(\varepsilon) &= \frac{1-\pi}{n\ \pi} \\ \mu_3(\varepsilon) &= \frac{(1-\pi)(1-2\pi)}{(n\pi)^2} \\ \mu_4(\varepsilon) &= \frac{3(1-\pi)^2}{(n\pi)^2} + \frac{(1-\pi)(1-6\pi(1-\pi))}{(n\pi)^3} \end{aligned}\right\} \tag{8}$$

Introducing the number of "successes" (or injuries in our context) $m = n\pi$, and assuming π to be negligibly small relative to 1, one obtains the approximation

$$\left.\begin{aligned} \mu_2(\varepsilon) &\approx \frac{1}{m} \\ \mu_3(\varepsilon) &\approx \frac{1}{m^2} \\ \mu_4(\varepsilon) &\approx \frac{3}{m^2} + \frac{1}{m^3} \end{aligned}\right\} \qquad (9)$$

Later we will use $t = 1/m$ to simplify the writing of the formulas.

To calculate powers of r, we need

$$\left.\begin{aligned} (1+\varepsilon)^2 &= 1 + 2\varepsilon + \varepsilon^2 \\ (1+\varepsilon)^3 &= 1 + 3\varepsilon + 3\varepsilon^2 + \varepsilon^3 \\ (1+\varepsilon)^4 &= 1 + 4\varepsilon + 6\varepsilon^2 + 4\varepsilon^3 + \varepsilon^4 \end{aligned}\right\} \qquad (10)$$

and

$$\left.\begin{aligned} \frac{1}{1+\varepsilon} &= 1-\varepsilon+\varepsilon^2-\varepsilon^3+\varepsilon^4\ldots \\ \left(\frac{1}{1+\varepsilon}\right)^2 &= 1-2\varepsilon+3\varepsilon^2-4\varepsilon^3+5\varepsilon^4\ldots \\ \left(\frac{1}{1+\varepsilon}\right)^3 &= 1-3\varepsilon+6\varepsilon^2-10\varepsilon^3+15\varepsilon^4\ldots \\ \left(\frac{1}{1+\varepsilon}\right)^4 &= 1-4\varepsilon+10\varepsilon^2-20\varepsilon^3+35\varepsilon^4\ldots \end{aligned}\right\} \qquad (11)$$

Taking expectations, one obtains

$$\left.\begin{aligned} E(1+\varepsilon) &= 1 \\ E(1+\varepsilon)^2 &= 1 + \mu_2 \\ E(1+\varepsilon)^3 &= 1 + 3\mu_2 + \mu_3 \\ E(1+\varepsilon)^4 &= 1 + 6\mu_2 + 4\mu_3 + \mu_4 \end{aligned}\right\} \qquad (12)$$

and

$$\left.\begin{aligned} E\left(\frac{1}{1+\varepsilon}\right) &= 1 + \mu_2 - \mu_3 + \mu_4 \ldots \\ E\left(\frac{1}{1+\varepsilon}\right)^2 &= 1 + 3\mu_2 - 4\mu_3 + 5\mu_4\ldots \\ E\left(\frac{1}{1+\varepsilon}\right)^3 &= 1 + 6\mu_2 - 10\mu_3 + 15\mu_4\ldots \\ E\left(\frac{1}{1+\varepsilon}\right)^4 &= 1 + 10\mu_2 - 20\mu_3 + 35\mu_4\ldots \end{aligned}\right\} \qquad (13)$$

If we substitute the approximations (9) and use $t = 1/m$, we obtain

$$\left.\begin{aligned} E(1+\varepsilon)^2 &\approx a_2 = 1+t \\ E(1+\varepsilon)^3 &\approx a_3 = 1 + 3t + t^2 \\ E(1+\varepsilon)^4 &\approx a_4 = 1 + 6t + 7t^2 + t^3 \end{aligned}\right\} \qquad (14)$$

and

$$\left.\begin{aligned} E\left(\frac{1}{1+\varepsilon}\right) &\approx b_1 = 1 + t + 2t^2 + t^3 \\ E\left(\frac{1}{1+\varepsilon}\right)^2 &\approx b_2 = 1 + 3t + 11t^2 + 5t^3 \\ E\left(\frac{1}{1+\varepsilon}\right)^3 &\approx b_3 = 1 + 6t + 35t^2 + 15t^3 \\ E\left(\frac{1}{1+\varepsilon}\right)^4 &\approx b_4 = 1 + 10t + 85t^2 + 35t^3 \end{aligned}\right\} \qquad (15)$$

We will later also need b_1^2, b_1^3, and b_1^4 and a_2^2. The approximations up to t^3 are:

$$\left.\begin{aligned} a_2^{\,2} &= 1 + 2t + t^2 \\ b_1^{\,2} &= 1 + 2t + 5t^2 + 6t^3 \\ b_1^{\,3} &= 1 + 3t + 9t^2 + 16t^3 \\ b_1^{\,4} &= 1 + 4t + 14t^2 + 32t^3 \end{aligned}\right\} \qquad (16)$$

We also will use that for independent random variables x and y

$$E(xy) = E(x)E(y) \qquad (17)$$

holds.

Finally, we will use the following relations between the central moments μ_i and non-central moments μ_i':

$$\left.\begin{aligned} \mu_2 &= \mu_2' - (\mu_1')^2 \\ \mu_3 &= \mu_3' - 3\mu_1'\mu_2' + 2(\mu_1')^3 \\ \mu_4 &= \mu_4' - 4\mu_1'\mu_3' + 6(\mu_1')^2\mu_2' - 3(\mu_1')^4 \end{aligned}\right\} \qquad (18)$$

4. The First Moment

4.1 Approximation Using Linear Terms Only

If one expands r, considering only the linear terms, one obtains

$$r = 1 + \varepsilon_1 + \varepsilon_4 - \varepsilon_2 - \varepsilon_3 \tag{19}$$

and therefore

$$E(r) = 1. \tag{20}$$

4.2 Approximation Using Terms up to the Second Order

An expansion up to second order terms is

$$r = (1+\varepsilon_1)(1+\varepsilon_4)(1-\varepsilon_2+\varepsilon_2^2)(1-\varepsilon_3+\varepsilon_3^2) \tag{21}$$

$$= 1 + \varepsilon_1+\varepsilon_4-\varepsilon_2-\varepsilon_3+\varepsilon_1\varepsilon_4-\varepsilon_1\varepsilon_2-\varepsilon_1\varepsilon_3-\varepsilon_4\varepsilon_2-\varepsilon_4\varepsilon_3+\varepsilon_2\varepsilon_3+\varepsilon_2^2+\varepsilon_3^2.$$

Because independence between the ε_i was assumed, this gives

$$E(r) = 1 + \mu_2(\varepsilon_2) + \mu_2(\varepsilon_3). \tag{22}$$

This shows that the expected value of R is greater than $(p_1/p_2)/(p_3/p_4)$; therefore using this as an estimator for R overestimates the effectiveness 1-R. To assess the magnitude of this bias, we use the approximation (9) and obtain:

$$E(r) \approx 1 + \frac{1}{m_2} + \frac{1}{m_3}. \tag{23}$$

For the situation where each of the four p's is calculated from 20 injuries,

$$E(r) \approx 1.1,$$

for the situation where each is based on 100 injuries,

$$E(r) \approx 1.02.$$

These biases may appear small. However, if e.g., R = 0.95, was estimated, in the first case the true expected value would be R' = 1.04, and instead of an effectiveness 1-0.95 = 0.05, 1-1.04 = -0.04 should be used in the first case: this means that the expected effect is approximately the opposite of what one would expect from the biased estimate. In the second case R' = 0.97 is the unbiased expected value and the effectiveness should be 0.03 instead of 0.05, a reduction by 40%!

4.3 Approximation Using Terms up to the Third Order

Using equation (17), we obtain

$$E(r) = E(1+\varepsilon_1)E(1+\varepsilon_4)E\left(\frac{1}{1+\varepsilon_2}\right)\ E\left(\frac{1}{1+\varepsilon_3}\right), \tag{24}$$

and from (12) and (15)

$$\begin{aligned} E(r) &= (1+t_2+2t_2^2+t_2^3)(1+t_3+2t_3^2+t_3^3) \\ &= 1+t_2+t_3+2t_2^2+t_2t_3+2t_3^2+t_2^3+2t_2^2t_3+2t_2t_3^2+t_3^3, \end{aligned} \tag{25}$$

retaining only terms up to the third order. To make estimates of the order of magnitude of the higher order terms, we assume $t_2 = t_3 = T$ and obtain

$$\begin{aligned} E(r) &= 1+2T+5T^2+6T^3 \\ &= 1+2T\left(1+\frac{5}{2}T+3T^2\right) \end{aligned} \tag{26}$$

For the first case discussed in 4.2, m = 20, T = 0.05, one obtains E(r) = 1.11, compared with 1.1 in Section 4.3. Whether this difference is important depends on how large R is. For the second case, m = 100, T = 0.01, the effect is to increase E(r) from 1.02 to 1.0205, which is negligible.

5. The Second Moment

5.1 Approximation Using Linear Terms Only

Using (12), (13) and (17), we obtain

$$E(r^2) = (1+\mu_2(\varepsilon_1))(1+\mu_2(\varepsilon 4))(1+3\mu_2(\varepsilon 2))(1+3\mu_2(\varepsilon 3))$$
$$= 1 + \mu_2(\varepsilon_1) + \mu_2(\varepsilon_4) + 3\mu_2(\varepsilon_2) + 3\mu_2(\varepsilon_3), \tag{27}$$

when only first order terms in the μ_2 are retained. In order to calculate $\mu_2(r)$, we use (18) which requires $(\mu_1'(r))^2$.

$$\mu_1'(r) = (1+\mu_2(\varepsilon_2))\ (1+\mu_2(\varepsilon_3))\ \text{and} \tag{28}$$

$$(\mu_1'(r))^2 = 1 + 2\mu_2(\varepsilon_2) + 2\mu_2(\varepsilon_3)\ , \tag{29}$$

retaining only the first order terms in the μ_2. Combining (27) and (29) according to (18) gives

$$\mu_2(r) = \mu_2(\varepsilon_1) + \mu_2(\varepsilon_2) + \mu_2(\varepsilon_3) + \mu_2(\varepsilon_4); \tag{30}$$

the variance of the double ratio is the sum of the variances of the four factors.

5.2 Approximation Using Terms up to the Third Order

For this approximation we immediately use the approximations (15) and (16). First we have

$$\mu_2'(r) = E(r^2) = E(1+\varepsilon_1)^2 E(1+\varepsilon_4)^2 E\left(\frac{1}{1+\varepsilon_2}\right)^2 E\left(\frac{1}{1+\varepsilon_3}\right)^2$$
$$= (1+t_1)(1+t_4)(1+3t_2+11t_2^2+5t_2^3)(1+3t_3+11t_3^2+5t_3^3)$$
$$= (1+t_1+t_4+t_1t_4)(1+3t_2+3t_3+11t_2^2+9t_2t_3+11t_3^2+5t_2^3+33t_2^2t_3+33t_2t_3^2+5t_3^2)$$
$$= 1 + 3t_2+3t_3+11t_2^2+9t_2t_3+11t_3^2+5t_2^3+33t_2^2t_3+33t_2t_3^2+5t_3^2 \tag{31}$$
$$+(t_1+t_4)(1+3t_2+3t_3+11t_2^2+9t_2t_3 +11t_3^2) + t_1t_4(1+3t_2+3t_3),$$

if one retains only terms up to the third order. Since

$$\mu_1' = b_1(\varepsilon_2)b_1(\varepsilon_3) \tag{32}$$

(16) gives

$$(\mu_1')^2 = (1+2t_2+5t_2^2+6t_2^3)(1+2t_3+5t_3^2+6t_3^3) \qquad (33)$$
$$= 1 + 2t_2+2t_3+5t_2^2+4t_2t_3+5t_3^2+6t_2^3+10t_2^2t_3 +10t_2t_3^2+6t_3^3$$

retaining only terms up to the third order. Combining (31) and (33) according to (18) gives

$$\mu_2 = t_1+t_2+t_3+t_4$$
$$+6t_2^2+5t_2t_3+6t_3^2-t_2^3+23t_3^2t_3+23t_2t_3^2-t_3^3 \qquad (34)$$
$$+(t_1+t_4)(3t_2+3t_3+11t_2^2+9t_2t_3+11t_3^2)$$
$$+t_1t_4(1+3t_2+3t_3).$$

The linear terms correspond to the sum of the four $\mu_2(\varepsilon_i)$. The higher order terms are impracticably complicated to be used. Therefore, we use again the special case where all $t_i = T$ and obtain:

$$\mu_2(r) = 4T + 30T^2 + 112T^3$$
$$= 4T\ (1 + \frac{15}{2}T^m + 23T^2) \qquad (35)$$
$$= 4Tf$$

Since 4T corresponds to the linear terms of $\mu_2(r)$, f is the factor by which it has to be increased. For m = 20, one has f = 1.43, and for m = 100, one has f = 1.08, for m = 500, f = 1.015. Thus, for m = 20, the higher terms are not negligible; for 100 they will usually be so, whereas for 500 they are practically always negligible.

6. The Third Moment

(18) gives for the third moment

$$\mu_3 = \mu_3' - 3(\mu_1'\mu_2') + 2(\mu_1')^3 \tag{36}$$

Using directly (14), (15) and (16) and substituting one T for the t_i, we obtain

$$\begin{aligned}\mu_3'(r) &= (1+3T+T^2)^2 (1+6T+35T^2+15T^3)^2 \\ &= (1+6T+11T^2+6T^3)(1+12T+106T^2+450T^3) \\ &= 1 + 18T+189T^2+1224T^3\end{aligned} \tag{37}$$

omitting all terms of higher than third order.

Combining

$$\begin{aligned}\mu_2'(r) &= (1+T)^2(1+3T+11T^2+5T^3)^2 \\ &= 1 + 8T + 44T^2 + 144T^3\end{aligned} \tag{38}$$

with (26) gives

$$\begin{aligned}\mu_1'(r)\mu_2'(r) &= (1+2T+5T^2+6T^3)(1+8T+44T^2+144T^3) \\ &= 1 + 10T + 65T^2 + 278T^3\end{aligned} \tag{39}$$

up to terms of the third order.

Finally, we need

$$(\mu_1')^3 = [1+2T+5T^2+6T^3]^3 \tag{40}$$

according to (26). This gives

$$(\mu_1')^3 = 1 + 6T + 27T^2 + 86T^3 \tag{41}$$

again omitting terms of higher than third order. Combining (37), (39) and (41) according to (36) gives

$$\mu_3 = 48T^2 + 562\ T^3. \tag{42}$$

Since μ_3 is not easily interpretable, we will use it only for the Gram-Charlier series expansion to be performed later.

7. The Fourth Moment

$$\mu_4 = \mu_4' - 4(\mu_1'\mu_3') + (6(\mu_1')^2\mu_2') - 3(\mu_1')^4. \tag{43}$$

$$\mu_4' = E(r^4) = E(1+\varepsilon_1)^4 E(1+\varepsilon_4)^4 E\left(\frac{1}{1+\varepsilon_2}\right)^4 E\left(\frac{1}{1+\varepsilon_3}\right)^4. \tag{44}$$

Using (14) and (15) this becomes:

$$\begin{aligned}\mu_4' &= (1+6T+7T^2+T^3)^2 (1+10T+85T^2+35T^3)^2 \\ &= (1+12T+50T^2+86T^3)(1+20T+270T^2+1770T^3) \\ &= 1 + 32T + 560T^2 + 6096T^3\end{aligned} \tag{45}$$

if omitting terms of higher than third order.

Combining (26) and (37) gives

$$\begin{aligned}\mu_1'(r)\mu_3'(r) &= (1+2T+5T^2+6T^3)(1+18T+189T^2+1224T^3) \\ &= 1 + 20T + 230T^2 + 1698T^3\end{aligned} \tag{46}$$

Combining the simplified versions of (31) and (33) gives

$$\begin{aligned}(\mu_1'(r))^2\mu_2'(r) &= (1+4T+14T^2+32T^3)(1+8T+44T^2+144T^3) \\ &= 1 + 12T + 90T^2 + 464T^3.\end{aligned} \tag{47}$$

Finally, by squaring (33) we obtain

$$\begin{aligned}(\mu_1')^4 &= (1 + 4T + 14T^2 + 32T^3)^2 \\ &= 1 + 8T + 44T^2 + 176T^3.\end{aligned} \tag{48}$$

Combining (45), (46), (47) and (48) according to (43), we obtain

$$\begin{aligned}\mu_4 &= 1 + 32T + 560T^2 + 6096T^3 \\ &\quad -4(1+20T+230T^2+1698T^3) \\ &\quad +6(1+12T+90T^2+464T^3) \\ &\quad -3(1+8T+44T^2+176T^3) \\ &= 48T^2 + 1560T^3.\end{aligned} \tag{49}$$

Since $\mu_2 = 4T+\ldots$, the excess or curtosis μ^4/μ_2^2 approaches 3 for small values of T; this is the value for the normal distribution.

8. Gram-Charlier Series Expansion

8.1 Basic Formulas

A probability density function f(x) can be expanded into a series

$$f(x) = \phi(x)\ (1+ \frac{\mu_3^*}{6} H_3(x) + \frac{\mu_4^*-3}{24} H_4(x) +\ldots), \tag{50}$$

where it is assumed that x is transformed to have mean zero and variance 1; μ_3^* and μ_4^* are the correspondingly transformed third and fourth moments. $H_i(x)$ are the Hermite polynomials

$$\begin{aligned} H_2(x) &= x^2-1 \\ H_3(x) &= x^3-3x \\ H_4(x) &= x^4-6x^2+3 \end{aligned} \tag{51}$$

$\phi(x)$ is the normal probability density.

The cumulative probability function can be expressed as

$$F(x) = \Phi(x)-\phi(x)\ (\frac{\mu_3^*}{6} H_2(x) + \frac{\mu_4^*-3}{24} H_3(F)+\ldots.) \tag{52}$$

where $\Phi(x)$ is the cumulative normal probability distribution.

In standard texts I found no remainder terms indicating how accurately a finite series using only a few terms of the infinite series approximates the true distribution.

8.2 Numerical Examples

8.2.1 m = 20

If we assume that all four p_i are estimated from 20 injury cases, and that the injury probability is small, we obtain:

First two moments (using linear terms only):

$$\begin{aligned} \mu_1' &= 1 \\ \mu_2 &= \frac{4}{20} = 0.2 \end{aligned} \tag{53}$$

First two moments (using terms up to the third order):

$$\begin{aligned} \mu_1' &= 1 + \frac{2}{20} + \frac{5}{20^2} + \frac{6}{20^3} = 1.113 \\ \mu_2 &= \frac{4}{20} + \frac{30}{20^2} + \frac{112}{20^3} = 0.289 \end{aligned} \tag{54}$$

First four moments (using terms up to the third order):

$$\begin{aligned} \mu_1' &= 1.113 \\ \mu_2 &= 0.289 \\ \mu_3 &= 0.190 \qquad \mu_3^* = \mu_3/\sqrt{\mu_2^3} = 1.223 \\ \mu_4 &= 0.315 \qquad \mu_4^* = \mu_4/\mu_2^2 = 3.772 \end{aligned} \tag{55}$$

Figure 1 shows the two tails of the cumulative distribution of r. The approximation of the first four moments was calculated from the Gram-Charlier series. It is presumably the closest approximation to the "true" distribution of r. The lower and upper 5th percentiles are at r = 0.37 and r = 2.26
The approximation of the first two moments using terms up to the third order is based upon a normal distribution with the "true" mean and variance; the lower and upper 5th percentiles are 0.26 and 2.00
The approximation of the first two moments using linear terms only is based upon a normal distribution with mean 1 and variance = $\varepsilon_1^2+\varepsilon_2^2+\varepsilon_3^2+\varepsilon_4^2$. It has the lower and upper fifth percentiles 0.22 and 1.74.
Both of the latter two approximations are unsatisfactory since the effectiveness is 1-R; using one of them may result in accepting an effect as significant which is with a fairly high probability due to chance. r = 2.04 would be considered significant at the 99% level, whereas it is only 92.5% significant with the "true" distribution.

8.2.2 m = 100

The corresponding results are:

First two moments (using linear terms only):

$$\begin{aligned} \mu_1' &= 1 \\ \mu_2^2 &= \frac{4}{100} = 0.04 \end{aligned} \tag{56}$$

First two moments (using terms up to the third order):

$$\mu_1' = 1 + \frac{2}{100} + \frac{5}{100^2} + \frac{6}{100^3} = 1.021 \tag{57}$$

$$\mu_2 = \frac{4}{100} + \frac{30}{100^2} + \frac{112}{100^3} = 0.0431$$

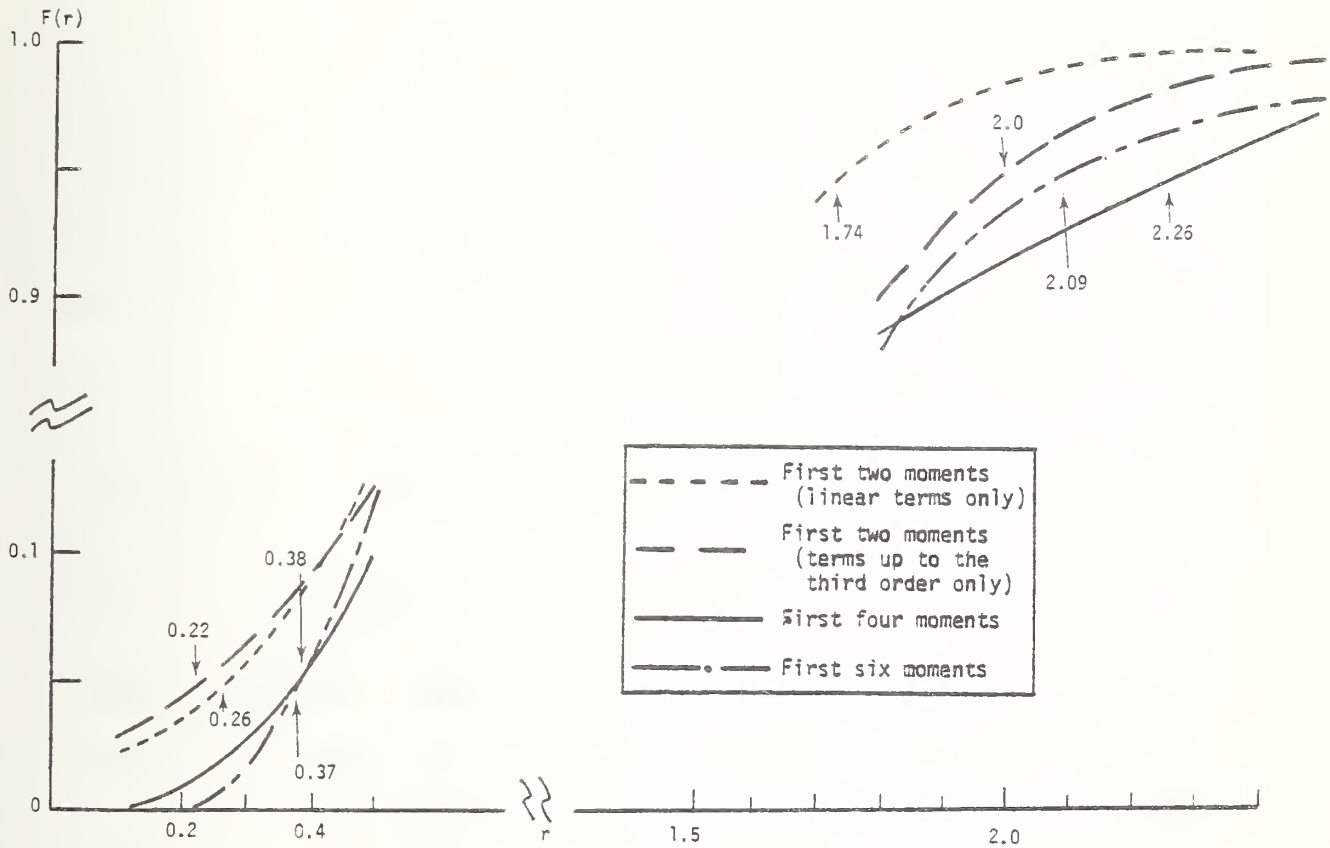

Figure 1. Two tails of the cumulative distribution of r (m=20).

First four moments (using terms up to the third order):

$$\mu_1' = 1.021$$

$$\mu_2 = 0.0431 \tag{58}$$

$$\mu_3 = 0.00536 \quad \mu_3^* = \mu_3/\sqrt{\mu_2^3} = 0.599$$

$$\mu_4 = 0.00636 \quad = \mu_4^* = \mu_4/\mu_2^2 = 3.424$$

Figure 2 shows the tails of the corresponding distribution. Here, at the left tail, the differences between the three distributions are negligible. At the right tail, the difference between the approximations of the first four and the first two moments (using terms up to the third order) is negligible; the difference between them and the approximation of the first two moments using linear terms only may just be important in some cases.

8.3 Approximate Estimation of Confidence Limits

To calculate the entire distribution or part of it to determine for which x', $F(x') = 1-\alpha$ holds is relatively time-consuming. An approximation may be sufficient. We write

$$F(x) = F(x_o) + F'(x_o)\ (x - x_o) \tag{59}$$

We now chose x_o so that $\phi(x_o) = 1-\alpha$, x_o is the derived confidence limit for the normal distribution. We define x' as the confidence limit for the studied distribution: $F(x') = 1-\alpha$. Then we have

$$x' - x_o = \frac{1-\alpha-F(x_o)}{F'(x_o)}. \tag{60}$$

(52) gives

$$F(x_o) = \phi(x_o) - \Phi(x_o)\left(\frac{\mu_3^*}{6} H_2(x_o) + \frac{\mu_4^*-3}{24} H_2(x_o)\right)$$

$$= 1-\alpha-\Phi(x_o)\left(\frac{\mu_3^*}{6} H_2(x_o) + \frac{\mu_4^*-3}{24} H_3(x_o)\right) \tag{61}$$

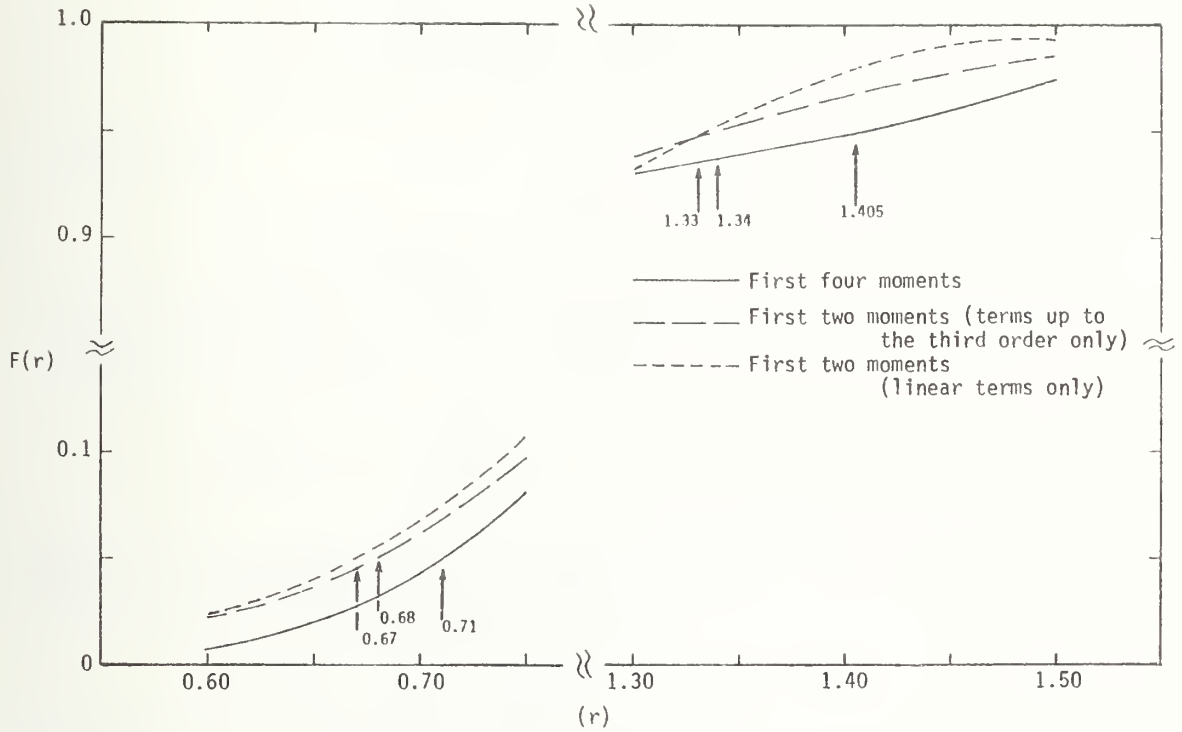

Figure 2. Two tails of the cumulative distribution of r(m=100).

Since $F'(x) = f(x)$, we can combine (60), (61) and (50) and obtain

$$x'-x_o = \frac{\frac{\mu_3^*}{6} H_2(x_o) + \frac{\mu_4^*-3}{24} H_3(x_o)}{1 + \frac{\mu_3^*}{6} H_3(x_o) + \frac{\mu_4^*-3}{24} H_4(x_o)} . \qquad (62)$$

If we use $\alpha = 0.05$ as an example, $x_o = 1.64$, and we have $H_2(x_o) = 1.690$, $H_3(x_o) = -0.509$, $H_4(x_o) = -5.904$. Therefore,

$$x'-1.64 = \frac{0.282\mu_3^* - 0.021(\mu_4^*-3)}{1-0.085\mu_3^* - 0.246(\mu_4^*-3).} \qquad (63)$$

Thus, one can calculate the approximate upper 95% confidence limit for any distribution, where the μ_3^* (skewness) and μ_4^* (excess, curtosis) are given.

9. Conclusions and Recommendations

The numerical examples suggest that for $m > 100$ one can use the normal approximation, preferably corrected for the bias in $\bar{r}$; but for $m > 400$ or 500, this is definitely not necessary.

For $m = 20$ the normal approximation, even if corrected for bias and with an inflated ε, is definitely inadequate. Somewhere between 20 and 100 is an m where it becomes sufficient to correct r and inflate ε. The approximations were derived for "small" values of the π_i. That means that the p_i have highly skewed distributions. For larger π_i the distributions are less skewed; for $\pi_i = 0.5$ they are symmetric. Therefore, one can expect that the normal approximations will be sufficient for smaller values of m than suggested above, if the π_i are not small.

For small values of m one should proceed as follows:

1) Calculate $\mu_i(\varepsilon_j)$
2) Calculate $E(\frac{1}{1+\varepsilon_j})^k$
3) Calculate $E(r^k)$
4) Calculate $\mu_k(r)$
5) Calculate $\mu_3^*(r)$ and $\mu_4^*(r)$
6) Apply equation (62) for the desired α

Elaboration

1) Calculate $\mu_i(\varepsilon_j)$
   i = order of moment, j index of p_j in $\frac{p_1}{p_2} : \frac{p_3}{p_4}$

Formulae (8) do this

2) Calculate $E\ (\frac{1}{1+\varepsilon_j})^k$; $E\ (1+\varepsilon_j)^k$. Assume that only the second order approximation will be used: k = 1, 2.

$$E\ (\frac{1}{1+\varepsilon_j}) = 1 + \mu_2(\varepsilon_j) - \mu_3(\varepsilon_j) + \mu_4(\varepsilon_j)$$

$$E\ (\frac{1}{1+\varepsilon_j})^2 = 1 + 3\mu_2(\varepsilon_j) - 4\mu_3(\varepsilon_j) + 5\mu_4(\varepsilon_j)$$

$$E\ (1+\varepsilon_j) = 1$$

$$E\ (1+\varepsilon_j)^2 = 1 + \mu_2(\varepsilon_j)$$

3) Calculate $E(r^k) = E(1+\varepsilon_1)^k\ E(1+\varepsilon_4)^k E\ (\frac{1}{1+\varepsilon_2})^k\ E\ (\frac{1}{1+\varepsilon_3})^k$

$\mu_k'(r) = E(r^k)$

4) Calculate $\mu_2(r)$. Use formula (18).

Calculate $\mu_k(R) = (\frac{\pi_1}{\pi_2} : \frac{\pi_3}{\pi_4})^k\ \mu_k(r)$

Calculate $\mu_k'(R) = \left(\frac{\pi_1}{\pi_2} : \frac{\pi_3}{\pi_4}\right) \mu_k'(r)$

5) Omit for this level approximation.

6) For $m_j > 100$, use a normal distribution with $\mu_1'(R)$ and $\mu_2(R)$

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